SCIENCE

Vol. 109 No. 2828 Friday, March 11, 1949

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Science, a weekly journal founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Editorial and Advertising Offices, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Telephone, Executive 6060. Cable address, SCIMAG, Washington, D. C. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph 4, Sec. 538, P.L. and R., authorized January 13, 1948.

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)ak Ridge National Laboratory

lvin M. Weinberg

)ak Ridge National Laboratory

DURING THE TWO YEARS that the development of nuclear energy in this country has been the responsibility of the U. S. Atomic nergy Commission, the large national laboratory has merged as a new entity, a new experiment in the onduct of organized research. Each of the laboraories—Argonne, Oak Ridge, Brookhaven—bears an dividual stamp imprinted by its history and its eography. This individuality manifests itself in diferences in atmosphere, in program, and in aims. hus, in order to understand the Oak Ridge National aboratory it is necessary first to trace its history.

The laboratory was organized under the name Clinn Laboratories (after the town of Clinton, Tennese, about eight miles from Oak Ridge), in the fall of 943. At that time it was a branch of the Metallurical Project—the University of Chicago Metallurical Laboratory and the Clinton Laboratories comrised the major units of the Project, under the overll direction of Arthur H. Compton. The laboratory self was directed by M. D. Whitaker, now president f Lehigh University.

The main job of the laboratory was to produce and xtract plutonium on a gram scale in order to test the easibility of the whole Hanford project. For this urpose an air-cooled graphite reactor was conructed. This reactor, the first with provision for rge scale heat removal, began operation on Novemer 4, 1943, and has operated satisfactorily as a reearch instrument and an isotope producer ever since. n addition, a chemical pilot plant for plutonium exaction was built; this is a relatively small version f the huge concrete structures at Hanford, where lutonium is extracted on a large scale by methods rst proved at Clinton Laboratories.

Since the laboratories were in effect a pilot plant— least on the chemical side—for the DuPont-operated anford Engineer Works, it was natural that the uPont Company played an important role in the rly history of Clinton Laboratories. The University f Chicago operated the institution; however, the scitists and engineers at the DuPont Company and at e University of Chicago collaborated in designing the actor and the chemical facilities, and DuPont was e construction contractor for the whole installation. addition, the laboratories were used as a training ound for the workers at DuPont who were ultitely destined to operate the Hanford establishment. Many of the laboratory's operating staff were actually DuPont employees on loan to the University of Chicago. Thus industrial and academic influences have both been strongly felt at the laboratory from its earliest days. An atmosphere which is a blend of these two has naturally developed there.

The original purpose of Clinton Laboratories dictated the composition of its staff. Chemistry and chemical engineering (the chemical engineering carried out in the "technical" division, so called because the name is in common use by the DuPont Company) made up more than ninety percent of the scientific effort. This emphasis on chemistry and chemical engineering at Oak Ridge has in some measure persisted ever since. In addition, there was a small physics staff that directed the construction of the reactor and performed experiments with it, a small biology and medical staff, and an operation staff of technicians who later took charge of the routine production of radioisotopes. The technical direction of the laboratory at this time (1943–46) was the responsibility of R. L. Doan, research director.

Oak Ridge functioned as an adjunct of the Chicago Metallurgical Laboratory all through the war. Relations with Chicago were extremely close—monthly information meetings were held there at which research results from the two groups were exchanged and discussed. There were many problems—usually chemical—which were attacked jointly.

The very close relation between Clinton and Chicago remained until the end of the war. In June 1945, when the laboratory population had grown to 1,088, 250 of them technical staff members, it was arranged by the Manhattan Engineer District to transfer the laboratory operating contract to the Monsanto Chemical Company of St. Louis. The laboratory therefore withdrew from the University of Chicago Project and embarked on an independent course, with an overall program much broader than the originally conceived program of chemistry and chemical engineering. A number of scientists from Chicago who had been interested in the long range possibilities of atomic energy joined the laboratory, and its program veered toward the development of new reactor types. Physics and mechanical engineering were strengthened, since these disciplines are important for reactor development. In addition, there was a general broadening of the laboratory's work in pure science.

The large scale production of radioisotopes for scientific and therapeutic purposes was established as an important function of the Clinton Laboratories in 1945. It has continued ever since to be one of the most significant activities of the laboratory—and in fact, one of the most significant activities of the whole Atomic Energy Commission.

In May, 1946, Dr. Whitaker left the laboratory to become president of Lehigh University, and Dr. Doan returned to the Phillips Petroleum Company, from which he had been on leave. E. P. Wigner, on leave from Princeton University for a year, was named director of research and development, and J. H. Lum of the Monsanto Company became executive director.

The year during which Professor Wigner directed the laboratory was one of intense activity and expansion. A metallurgy division was established, and the biology division increased greatly in size. Under the direction of A. Hollaender, its approach to the problem of the biological effects of radiation became microbiological and biochemical rather than mammalian. The physics, chemistry, technical, and health physics divisions also increased in size and scope.

The laboratory program centered even more closely than before around the science and technology of nuclear reactors, although this preoccupation with reactor development was not so much the result of Commission directive as it was the outgrowth of the natural interests of the staff, particularly Dr. Wigner.

One of the most interesting activities at the laboratory during this period was the Clinton Laboratories Training School, directed by F. Seitz. Professor Wigner and his group at the Chicago Metallurgical Laboratory had done a great deal of long range thinking on the possibilities of nuclear energy, and on the codification of nuclear technology into a discipline which had its own tradition and could be conveyed to newcomers in the field. Because of security restrictions it seemed impractical to carry out the necessary training in nuclear technology within the usual educational agencies. Professor Wigner therefore conceived the notion of establishing a nuclear technology training school within Clinton Laboratories. To this school were invited about 40 scientists and engineers, both industrial and academic, interested in entering the new field. The "students" took part in the regular laboratory activities besides attending classes given by staff members, and after the year's stay they were expected to carry their training back to their home institutions.

Although the training school operated for only a year its alumni include several of the best known figures in the American atomic energy effort. There were administrative difficulties of the sort that beset most enterprises at the outset, but the training scho was a success as measured by the influence its st dents have had on the national nuclear energy deve opment.

Professor Wigner's leave from Princeton ended i August, 1947. About the same time, the Monsan Chemical Company decided, in agreement with t Atomic Energy Commission, not to renew its contra for operation of the laboratory. There followed period of administrative uncertainty, during part which the University of Chicago was the presumpti contractor. This period ended March 1, 1948, wh the Carbide and Carbon Chemicals Corporation to over operation of the laboratory, now called O Ridge National Laboratory, on a four-year contra The Carbide Corporation had already been operati the other two Oak Ridge installations—the K-25 gas ous diffusion plant and the Y-12 electromagne plant—and the extraordinarily well-equipped proc and development laboratories connected with the

Two events of extreme importance to the laborato occurred during 1946–47. First, the Oak Ridge Ins tute of Nuclear Studies was organized. This agen representing 19 southern universities,[1] seeks to esta lish cooperative arrangements between the Oak Rid National Laboratory (as well as the other plant la oratories) and the member institutions in all scienti areas where such cooperation can be fruitful for t laboratory and for the member institutions. Th arrangements are made, via the ORINS, for stude from outside universities to do Ph.D. thesis work Oak Ridge. Again, faculty members of the ORI universities are given the opportunity to work in O Ridge National Laboratory or in the plant devel ment laboratories, to learn new techniques and meet distinguished men in the field who often visit laboratories, and to use this knowledge in their o research and teaching activities. In this respect Oak Ridge Institute of Nuclear Studies operates much the same way as do the Associated Universi at Brookhaven, or the Board of Governors at gonne. It is to be hoped that the Oak Ridge tional Laboratory will play a profoundly import part in the scientific and cultural development of Southland. The degree to which this promise is filled will depend, of course, on the imaginat brought to bear on developing fruitful means of c tact between the laboratory and the southern region

[1] Alabama Polytechnic Institute, University of Arkan University of Alabama, Duke University, Emory Univer University of Florida, Georgia School of Technology, Un sity of Georgia, University of Kentucky, Louisiana S University, University of Louisville, University of N Carolina, University of Mississippi, University of Tenne Tulane University, University of Texas, University of ginia, Vanderbilt University, Catholic University of Ame

The second event of great importance was the decision, on December 27, 1947, to concentrate reactor technology at the Argonne National Laboratory and to concentrate at Oak Ridge chemical technology, isotope production, and basic research in chemistry, physics, biology, and metallurgy, the basic research to be carried out in such a way as to stimulate cooperation with the southern institutions and the ORINS. In a certain sense this decision represented a partial return to the original concept of the old Clinton Laboratories, the chemical engineering installation of the Plutonium Project. However, more and more of the laboratory's effort had been directed toward reactor technology and basic research since the early days. The decision to merge the ORNL reactor effort at Argonne naturally caused considerable uncertainty among the scientists at Oak Ridge, the degree of dislocation varying from division to division, depending on how the new directive affected work done there.

It is fair to state that the laboratory has readjusted to its new status remarkably well, and has even acquired greater stability and permanence, because:

(1) The question of contractor has been settled on a long term basis; (2) The relative positions of basic research in the sciences and applied chemical technology have been established—it has become clear that it is perfectly possible for the two to flourish side by side, and in fact, to be fertilized by each other in this juxtaposition; (3) Personnel relations at the Carbide and Carbon Chemicals Corporation are handled well, in a manner consistent with the fact that the scientific staff has an esprit de corps and a loyalty to Oak Ridge; (4) Finally, the role of the Southern universities in the laboratory has been defined, and the hope that Oak Ridge will become the center of basic research in the South materializes with each additional Ph.D. student, with each visiting faculty member, and with each lecture by an Oak Ridge scientist at a Southern institution.

At present the laboratory population is about 2,000, including about 600 technical staff members. The laboratory is divided into six scientific divisions: biology, chemistry, health physics, metallurgy, physics, and technical. In addition, there is an operating department, responsible for radioisotope production and pile operation, and several service departments.

About half of the laboratory's work is classified. The other half includes basic studies in many fields, some of which have already become almost classical. Among these studies are:

Neutron diffraction. This technique, for which the chain reactor is ideally suited, has become an extraordinarily powerful tool for the investigation of the structure of hydrogen-containing crystals. Since chain reactors are so expensive that in all probability only large organizations like national laboratories will ever be able to afford them, the use of neutron diffraction for the systematic study of crystals and molecular structure is apt to remain a most important basic scientific function of the national laboratories.

Ion exchange methods in inorganic chemistry. The systematic separation and purification of chemical compounds by selective adsorption on organic zeolites have been developed at ORNL as a tool in many chemical investigations. For example, the preparation of exceedingly pure (99.9% or better) rare earths was first performed at ORNL, and has since become a fairly routine procedure.

Isolation and chemical properties of elements 61 and 43. Element 61, prometheum, and element 43, technetium, were first isolated in milligram amounts at ORNL from the fission product wastes, and many of their chemical properties have been determined. The work on these elements typifies the sort of large scale "hot" operations which the extensive radiochemical facilities at ORNL make particularly feasible.

The facilities of the Oak Ridge National Laboratory bear evidence of the diversity which is the mark of a war-born activity. The biology division is housed in buildings which were intended for use in the electromagnetic isotope separation process, but which have been converted into one of the best-equipped biological laboratories in the world. The metallurgy laboratory is equipped with one of the largest exclusively experimental extrusion presses in the country; the physics division has at its disposal a helium liquefier and, jointly with the chemistry division, a Van de Graaf machine in addition to the chain reactor; the chemistry division possesses superb, high level, large scale hot laboratories, in addition to such relatively standard apparatus as an electron microscope and an X-ray and optical diffraction laboratory. This is only part of the equipment for which many millions of dollars have been spent at Oak Ridge National Laboratory since its inception.

In addition to the equipment at ORNL proper, there are available in the neighboring plant developmental laboratories excellent facilities for work in optical and mass spectroscopy, as well as huge vertical magnets suitable for cosmic ray investigations. Relations between ORNL and the two plant laboratories have been very close—to the mutual benefit of all three organizations—ever since the laboratory and the plants have been under one contracting agency.

Oak Ridge National Laboratory represents a unique experiment in scientific and governmental administration. It is a national institution operated by a pri-

vate corporation for the purpose of furthering nuclear chemical technology on the one hand, and basic research, in conjunction with the Southern universities, on the other. It is thus a microcosm in which are projected many elements of our modern American—and Southern—society.

Can such an experiment be made to work? It is important to remember that the national laboratory for nuclear research is a new species—that there are no blueprints for the successful national laboratory—and that there are probably several administrative setups that will prove to be workable. It has been stated that industry is not suited to manage a national laboratory dedicated in good measure to basic research—yet the experience of ORNL during the last year under Carbide management has demonstrated that first-rate basic research can be done in an industrial framework. One important reason is the fact that the subtle relations between staff and contractor have been so handled as to take into account the basic loyalties of the staff, which go primarily to the national laboratory rather than to the contracting agency.

Again it has been suggested that the successful national laboratory should be located close to a large city. Oak Ridge is rather isolated. But life in Oak Ridge and the other atomic cities has many attractive features. There exist cameraderie and opportunities to take active part in community and cultural activities which are quite beyond the prospect of the average city dweller. In large measure these features of life in Oak Ridge compensate for the cultural advantages of the large city—which so often are available but are left unused.

But it may be that the laboratory draws its essential strength from its position as the largest scientific institution in the South. It is commonplace to observe that the Southland is undergoing a modern industrial revolution—that living standards are increasing, and that, as a concomitant, a cultural rebirth is in the making. But the South has a long way to go, especially in the sciences. In making its influence felt throughout the scientific departments of the Southern universities, Oak Ridge National Laboratory, through the agency of the Oak Ridge Institute of Nuclear Studies, has a worthy educational mission to perform. Should it fulfill this mission then this fulfillment—this curious by-product of the atomic bomb—will almost surely rank in importance with any future technical advances which Oak Ridge National Laboratory—or any laboratory—can hope to achieve.

On the Calculation of Planet Temperatures From the Composition of Meteoritic Matter

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IN A RECENT PAPER, BROWN AND PATTERSON (2) STATE "the conclusion appears irrefutable that meteorites at one time were an integral part of a planet" similar in characteristics to the earth. The evidence for this conclusion which they emphasize especially consists of certain thermodynamic computations made on the basis of data which they have compiled. Careful analysis indicates, however, that even if we grant the assumptions involved in making these computations and even if we use the data assembled by Brown and Patterson, we should arrive at conclusions which are at variance with those proposed by these authors.

Brown and Patterson's thermodynamic calculations depend fundamentally on the assumption "that the observed distributions of elements [within meteorites] represent equilibrium distributions . . . [which] must have been established at temperatures of the order of 3,000° C and pressures of the order of 10^5–10^6 atms." The pressures specified depend, in turn, on the value assumed for the equilibrium temperature. It seems pertinent, therefore, to examine carefully the basis of the particular choice of temperature, and the degree of reliability of the value proposed.

The choice of 3,000° C as the equilibrium temperature is based on the correlations of data on equilibrium distributions between silicate and metal phases with the heats of formation of the oxides, in terms of the following *approximate* thermodynamic expression:

$$-RT \ln K \simeq \Delta H. \qquad (1)$$

The reliability of the calculated temperature depends, therefore, on the closeness of ΔH's for the formation

of oxides and silicates respectively, and on the possible error involved in the use of equation (1).[1]

Adequate thermodynamic data on silicates are very sparse. There are, however, half a dozen cases yielding sufficient information (*1*) to make a comparison between the ΔH's calculated from data on the heats of formation of silicates and of oxides respectively. The pertinent information is summarized in Table 1.

TABLE 1

COMPARISON OF ΔH'S FOR REACTION (2) CALCULATED FROM HEATS OF FORMATION OF SILICATES AND OF OXIDES RESPECTIVELY

Silicate	$\Delta Hf - \Delta Hf_{FeSiO_3}$	Oxide	$\Delta Hf - \Delta Hf_{FeO}$	Deviation
Al_2SiO_5	−350.2 kcal mole^{-1}	Al_2O_3	−315.7 kcal mole^{-1}	−34.5 kcal mole^{-1}
$BaSiO_3$	− 89.5	BaO	− 68.7	−20.8
$CaSiO_3$	−104.4	CaO	− 87.4	−17.0
($FeSiO_3$)	......	(FeO)	......	.....
$MgSiO_3$	− 74.0	MgO	− 81.8	7.8
$MnSiO_3$	− 27.8	MnO	− 32.2	4.4
Na_2SiO_3	− 97.7	Na_2O	− 35.2	−62.5

Even if we omit consideration of the case of Al, since there may be some doubt as to just how to correct the silicate data for the difference in valence states, it is apparent that differences from 4 to 60 kcal can be encountered. These deviations would have a profound effect on the calculated temperature, as will be indicated shortly.

The method used by Brown and Patterson (*2*) to obtain 3,000° C as their estimate of the temperature depends on the validity of equation (1). They have recognized, as have all physical chemists, that implicit in the use of this equation is the assumption that entropy changes in the reactions considered are negligible. Practically no reliable data are available to examine this assumption in the present systems.[2] In the absence of information on entropy changes, *equation (1) can be relied upon only for large ΔH's,* especially when the reactions considered occur at elevated temperatures; *yet Brown and Patterson find agreement with a temperature of 3,000° only for data with small values of ΔH,* as is apparent from their figure 3 (*2*). The method of presentation which they have used, however, tends to obscure the magnitude of these deviations. An enlightening insight into the seriousness of these discrepancies can be obtained from the following considerations.

From the data compiled by Brown and Patterson, it is possible to calculate temperatures for each of 16 reactions of the type

$$M + FeSiO_3 = MSiO_3 + Fe \qquad (2)$$

if one uses equation (1) and the oxide ΔH's. It is a significant coincidence that, on the whole, the higher the ΔH the higher the temperature (see Table 2);

TABLE 2

TEMPERATURES CALCULATED FROM HEATS OF REACTION FOR OXIDES

ΔH kcal/ mole O atom	T °K	ΔH kcal/ mole O atom	T °K
4.1	−1,580	− 7.8	3,320
19.3	6,450	− 8.2	2,700
23.6	2,650	−13.2	4,950
23.6	2,620	−30.7	5,000
25.1	2,960	−48.7	6,900
35.3	3,400	.....	....
39.3	4,900	.....	....
43.3	5,200	.....	....
67.3	4,200	.....	....
78.3	4,800	.....	....
86.3	7,600	.....	....

in other words, the more nearly one approaches a region where equation (1) is likely to be reliable, the higher the calculated temperature. For the Ca reaction, with the highest ΔH, T becomes 7,600° K. Furthermore, if the silicate enthalpy data are used instead of the oxide data, T becomes 9,200° K in the calcium case. Since entropy data are lacking, the correct answer may be even higher. Even an exceedingly conservative estimate for ΔS of only 1 cal mole^{-1} deg^{-1} makes a temperature in the neighborhood of 10,000° K highly plausible. In any event, one is forced to the conclusion that an estimate of 3,000° is based on the

[1] The propriety of using thermodynamic data obtained at temperatures near 300° K to draw conclusions about processes which occurred at temperatures from 10 to perhaps 30 times greater also requires critical comment. This aspect of their computations is not clearly dealt with by Brown and Patterson; nevertheless, it will not be pursued further in the present communication.

[2] K. K. Kelley (*3*) has reported standard entropy values of 16.2 and 21.3 cal mole^{-1} deg^{-1} for $MgSiO_3$ and $MnSiO_3$ respectively, at 298° K. Thus a ΔS of 5 entropy units occurs in at least one known case. Even at 3,000°, the additional uncertainty due to the neglect of ΔS thus becomes at least 15 kcal.

least reliable region of the data available,[3] and that the most justified use of equation (1) leads to considerably higher temperatures.[4]

Since there can be little doubt that the assumed temperature of equilibrium of 3,000° is far too low, we can turn attention to the pressure calculation. The basis of the estimate of 10^5 atm is the deviation between zur Strassen's experimental equilibrium constants and those calculated for the meteoritic matter. By assuming that temperature changes make no significant contribution, Brown and Patterson calculate that pressures of 10^5 atm could produce the difference. This calculation is correct in principle if we grant the assumption that there is no significant difference between zur Strassen's laboratory temperature of about 1,800° K and that in the planet of origin of the meteorites. However, it is quite clear from the preceding remarks that the temperature at which equilibrium was attained (if indeed the process is an equilibrium one) is substantially higher than 1,800°. Just how much higher it need be, to satisfy the fortyfold increase in equilibrium constant, cannot really be said. We might use the van't Hoff relation for the temperature dependence of the equilibrium constant, but the necessary integration can be carried out only with the additional assumption that ΔH does not change over a temperature interval of several thousand degrees, an assumption which is most hazardous, particularly if we approach a temperature region where the metals begin to vaporize.

The second argument which Brown and Patterson introduce to justify the acceptance of a pressure factor is again highly questionable. In considering the reaction

$$M + FeS = MS + Fe \qquad (3)$$

they find, in contrast to the silicates, no correlation between the equilibrium constant and ΔH. In proceeding to explain this apparent anomaly, they point out that the heats of formation of metallic sulfides are considerably lower than those of the corresponding oxides. From this observation, they make the unwarranted conclusion that ΔH for reaction (3) " will be generally considerably smaller" than ΔH for a reaction of the type of (2). Such a conclusion is itself unjustified, because ΔH for either (2) or (3) measures a *difference* in heats of formation, so that if both MS and FeS have enthalpies of formation equally less than those of the corresponding oxides, ΔH for reaction (3) would be the same as that for reaction (2). Actually, the two ΔH's run very nearly parallel, as estimated from data in Table 6 of Brown and Patterson. In four out of seven cases the *difference* is less than 5 kcal, in two less than 13 kcal, and only in one as high as 19 kcal. With the possible exception of the single value of 19 kcal, ΔH for reaction (3) is not "generally . . . considerably smaller" than that for (2). The differences are well within the most conservative estimates of the unreliability of oxide data for estimating ΔH's of silicate reactions.

It is true, however, that the absolute values of the ΔH's for the sulfide reactions calculated *for the limited number of systems considered* by Brown and Patterson are small, (between −12 and +23 kcal), but so are the ΔH's for the corresponding oxide systems (between −31 and +20 kcal). In fact, it should follow, since the best correlation between equilibrium constants and ΔH's in the oxide system was obtained for small ΔH's, that the sulfide systems should also show a definite correlation. Actually, as the authors point out, no significant correlation is evident.

From the remarks which have been made above, in connection with the reliability of equation (1), it is not particularly surprising that the equilibrium constants for reaction (3) are not related to the ΔH's; for this is an excellent example of a case where equation (1) cannot be expected to be valid, since the ΔH's are small. Hence, the introduction of the pressure factor to explain the lack of correlation in the sulfide systems is definitely unwarranted, for the lack of correlation is exactly what one should expect when an equation is applied under conditions which do not fulfill the postulates used in its derivation.

A similar procedure applied to any one of many common series of reactions produced in the laboratory under atmospheric pressure would lead one to the contradictory conclusion that pressures of many atmospheres had been used.[5]

Thus, it is apparent that the arguments proposed for the assumption of pressures near 10^5 atm cannot

[3] The unreliability of data in the region of small ΔH's is shown forcefully by the *negative* absolute temperature (see Table 2) obtained for a ΔH of 4.1 kcal.

[4] It should be pointed out, in addition, that temperatures calculated from large equilibrium constants, corresponding to large ΔH's, are more reliable than those calculated from small equilibrium contants, corresponding to small ΔH's, because of the logarithmic nature of the function relating K and T [see equation (1)]. Thus, for a K near 4×10^3 (Brown and Patterson's highest value), a tenfold error (i.e. 1,000%) in the equilibrium constant would produce an error of only 22% in the calculated temperature. On the other hand, an error of as little as 50% in a K near 4 would produce an error of 22% in the calculated temperature. Furthermore, for a constant near 2, a 50% discrepancy in K would introduce an infinitely large error in T.

[5] Some conception of the degree of unreliability of this procedure may be obtained from the following information. The very precise data of Herbert C. Brown and his associates (1947) on certain gas-phase equilibria have been analyzed by a procedure essentially the same as that used by Brown and Patterson, in which entropies of reaction are neglected. Representative values of the temperatures calculated are: −41,000, −4,500, 2,500, 3,400, 4,500, and 7,100° K in all cases. The actual temperature at which the experiments were carried out was 373° K in all cases.

maintained. The meager evidence which might be ed for a qualitative estimate of the pressure points ward a much lower value. The figure of 1.5×10^5 m quoted by Brown and Patterson is based on an sumed equilibrium temperature of 2,000° K. From e considerations outlined above, it is apparent that e temperature figure should be very much higher, d hence the pressure values considerably lower, per- ps even near 1 atm. There is certainly no convinc- g basis for a proposal of 10^5–10^6 atm. On the con- ry, the evidence points toward pressures much too w to be "comparable to the internal pressures exist- g within Mars."

Thus, even if we grant (for the purposes of the esent discussion) the questionable assumptions on e basis of which the computations have been made, e come to the conclusion that the more reliable of e data presented lead to temperatures far higher an the 3,000° reported by Brown and Patterson. rthermore, their estimate of a pressure of 10^5–10^6 m, calculated from an assumed temperature of 000° instead of 3,000°, cannot be maintained; for, has been pointed out, the temperature calculations greatest significance lead to values about five times higher than the assumed 2,000°; consequently, the pressures must be far below 10^5 atm, and a figure as low as 1 atm is entirely consistent with the available data.

Since the temperature and pressure values reported by Brown and Patterson are at variance with those obtained from a careful, critical analysis of the same basic data, any conclusions of cosmological significance drawn from their figures can hardly be proposed as compelling, let alone "irrefutable." While the hypothesis of a single planet of origin for meteorites may be an attractive one (*5*), as indeed its popularity for almost a century (*4*) testifies, there is as yet *no thermodynamic basis* for justifying this assumption.

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he Composition of Meteoritic Matter nd the Origin of Meteorites

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Professor Klotz (*6*), in his interesting and vigorous scussion of the chemical interpretation by Patterson d the writer (*2*) of the composition of meteoritic atter, has undertaken an analysis of the possibilities determining the temperatures within the planet om which meteorites may have had their origin. It unfortunate that Professor Klotz' discussion evi- nces misinterpretation of the intent of our survey, the methods used by us in arriving at our conclu- ons, of the validity of the data accumulated, and of e relative stress placed by us upon the various ints in our argument. Each of these items deserves rther comment.

In our investigations an effort was made primarily see whether or not some sort of chemical order ight exist in a field of inquiry where heretofore little der has been found. Our work was stimulated by e hope that, should indications of order become ap- rent, paths might be opened for fruitful and informative meteoritic research guided by sound chemical principles.

The sources of information utilized in our investigations of meteoritic relationships were varied, including notably:

(1) The variation of the nickel content in the metal phase of stony meteorites with the metal phase content and the relationships between the metal phase of stony meteorites and iron meteorites.

(2) The variation of the distribution coefficient of nickel between metal and silicate phases as a function of metal phase content.

(3) The dependence of the distribution coefficients of various elements between the silicate and metal phases upon the enthalpy change of the general reaction $M + FeSiO_3 \rightleftarrows MSiO_3 + Fe$ or $M + FeO \rightleftarrows MO + Fe$.

(4) The major differences existing between the me-

teoritic distribution coefficients of nickel between silicate, metal, and sulfide phases compared with those measured in the laboratory.

(5) The composition of the silicate phase of stony meteorites with respect to eight constituents as a function of metal phase content, and comparison with the composition of plateau basalt and igneous rock.

(6) The ratio of combined iron to metallic iron as a function of metal phase content.

(7) The atomic ratio of silicon to magnesium as a function of metal phase content.

(8) Frequency distribution relationships for various elements in meteorites as compared with distributions in igneous rocks.

(9) The frequency distribution of the metal phase of stony meteorites.

Given the various relationships mentioned above, the problem is to see whether any theory of meteorite origin is consistent with the data accumulated. We attempted to demonstrate that, from the chemical and geological points of view, the century-old planetary origin theory is quite consistent with the data available, *assuming* internal planetary temperatures of the order of those existing within the earth.

One of the more striking meteoritic regularities we stressed was the strong and surprisingly smooth dependence of the distribution coefficients between metal and silicate phases upon the affinities of the various elements for oxygen. In spite of the crudity of the available data, the necessary use of heats of formation of oxides rather than silicates, and the necessary ignoring of entropy and other corrections, this dependence is most marked, covering a range between platinum and magnesium of over 10^5. The dependence of the distribution coefficient upon ΔH suggests that elements distributed themselves between meteoritic phases under conditions approaching equilibrium, the appreciable scattering about any smooth curve that might be drawn through the points resulting from a combination of possible effects, notably: (a) The crudity of distribution coefficient data; (b) entropy effects; (c) change of ΔH with temperature; (d) pressure effects; (e) the use of oxide rather than silicate data, and (f) the necessary consideration of gross meteoritic matter instead of the stony and iron phases of individual meteorites. (See for example the strong dependence of the distribution coefficient of nickel upon the metal phase content in Fig. 2 in our paper in the *Journal of Geology*.)

Nickel is the only element for which adequate data exists, for comparison of meteoritic distribution coefficients with those observed in the laboratory. Zur Strassen measured the equilibrium $Ni + FeSiO_3$ [illegible] $NiSiO_3 + Fe$ at 1,840° K and found a value for [illegible] equilibrium constant of 7.25×10^{-3}, which is nearly [illegible] times smaller than the corresponding value of [illegible] observed in gross meteoritic material. One must as[illegible] At the temperatures which one might expect to find [illegible] the interiors of the inner planets, can this major di[illegible]ference be explained in a manner which is consiste[illegible] with the other sources of evidence outlined abov[illegible] The line of reasoning used by us was as follows:

It seems probable that the temperature at the cen[illegible] of the earth is closer to 2,000° C than to 3,000° C ([illegible] On the basis of considerations by ter Haar and oth[illegible] (*5*) on the mechanism of planet formation, it wo[illegible] appear unreasonable to expect temperatures mu[illegible] higher than this to exist in the interiors of any of [illegible] inner planets. In view of the relatively low me[illegible] temperatures to be expected for the *silicate mantle* [illegible] the earth (of the order of 2,000°–3,000° K) and ev[illegible] lower temperatures to be expected for the silic[illegible] mantle of the smaller planets, the major discrepan[illegible] existing between zur Strassen's measured equilibri[illegible] value and the observed meteoritic value appears to [illegible] difficult to explain on a temperature increase ba[illegible] alone.

Prof. Klotz is apparently under the misconcepti[illegible] that we estimated the temperature at which equil[illegible]rium might have occurred purely on thermodyna[illegible] grounds, and then used that calculated temperat[illegible] in order to estimate the pressure that would be [illegible]quired in order to elevate zur Strassen's observ[illegible] equilibrium value to that value observed in gross me[illegible]oritic matter. Actually, realizing that any estim[illegible] of temperature on thermodynamic grounds would [illegible] crude at best, we chose a reasonable temperature [illegible] an order of magnitude based upon two limits: ([illegible] the lower limit is set by the fact that the material m[illegible] have been molten, and (b) on the basis of geophysi[illegible] and astronomical evidence, the estimated internal te[illegible]peratures within the earth may be used to set [illegible] upper limit.

Fortunately zur Strassen measured the nickel-i[illegible] silicate equilibrium at two temperatures, thus perm[illegible]ting one to estimate roughly whether or not, [illegible] increasing the temperature to a value which is reas[illegible]able from the geophysical point of view, an equil[illegible]rium constant of the correct order of magnitude co[illegible] be obtained. Actually, even assuming a substant[illegible] value for ΔCp for the system, the temperature [illegible]quired becomes unreasonably high.

We demonstrated that if on the other hand [illegible] maintained temperatures not much higher than th[illegible] utilized by zur Strassen in his experiments (tempe[illegible]tures of reasonable order of magnitude from the [illegible]

ysical and astronomical points of view), the discpancy could be explained on the basis of a pressure ect of the order of magnitude of 10^5 atmospheres ing upon the system. This one case would of rse not be important in itself. It is significant to e, however, that in the only other case where comrison of meteoritic data with laboratory experiment possible, namely, the distribution of nickel between metal and *sulfide* phases, a similar discrepancy sts which is even more difficult to explain on a temrature change basis alone.[1] Indeed, it appears that two effects together cannot be explained on a temrature change basis alone. Yet, as in the case of the cate equilibrium, the assumption of a pressure effect the order of 10^5 atmospheres is sufficient to decrease Strassen's measured value to the observed metetic value. The nickel distribution between sulfide l metal (on which Prof. Klotz did not comment) ll the more significant because the discrepancy is in irection opposite to the silicate case, and the molar ume change of the reaction is also of opposite sign. us the pressure effect estimated from the sulfide e is nearly identical to that estimated from the cate case. In the silicate case one might conceivy rationalize the data by making rather drastic asptions as to temperature and ΔCp. But to do so the nickel-sulfide case becomes difficult in the exme.

It must be emphasized at this point that nickel disbutions in meteorites do not constitute the only rce of evidence for a pressure effect. There are eral regularities, among them, the combined iron metallic iron ratio, and the silicon to magnesium io, both as a function of metal phase content, ich can be understood if one assumes a pressure eft, but which are difficult to understand if it is ased that meteorites were formed in the absence of ravitational field of substantial order of magnitude.

Concerning Prof. Klotz' objection to our estimate temperature by means of the demonstrated increase distribution coefficient with increasing enthalpy nge in the reaction $M + FeO \rightleftarrows MO + Fe$, it must repeated that no effort was made to determine the ecise temperature of the presumed parent body. deed, how can one determine the precise temperae of a body which may vary in temperature from ew hundred degrees at its surface to perhaps a few usand degrees in its interior? Rather, it was our ention to see whether the order of magnitude of the nperature indicated by the gross meteoritic distribution data is consistent with the order of magnitude of temperatures generally believed to exist in the interiors of the inner planets, among them the earth, assuming the various contributions to ΔF to be statistically distributed.

In Fig. 3 in our paper in the *Journal of Geology* we plotted the various distribution coefficients against the enthalpy changes. Weighting each point according to our evaluation of the experimental precision of the distribution coefficients, we estimated the most reasonable slope to be one yielding a temperature of about 3,000° C, stressing that "the crudity of such an estimate cannot be over-emphasized." Unfortunately, we did not discuss the method by which we weighted the precisions of the points, believing it to be obvious to anyone reasonably familiar with the difficulties involved in meteorite analysis.

Prof. Klotz has attacked this estimate essentially on the grounds that the greater the enthalpy change, the less important become the other contributions to the free energy change. He suggests that, if one is to estimate temperatures, considerably more weight should be placed upon those cases possessing large enthalpy changes (negative or positive).

This would be correct were it not for an important fact completely ignored by Prof. Klotz: Very large and very small distribution coefficients between meteoritic phases are difficult to determine, the errors being such that large coefficients as determined are usually too low, and the low coefficients are usually too high, by as much as several orders of magnitude. The reasons for this are twofold. First, it is exceedingly difficult to obtain either the metal or the silicate phase in pure form. The metal phase in particular is difficult to obtain completely free of silicate. Second, most meteorite constituents exist in exceedingly small abundance. In such cases, if the distribution coefficient is either very large or very small, the analytical problems become almost insurmountable. As the result of these considerations, *the distribution coefficients for those elements possessing high coefficients must be considered lower limits; the distribution coefficients for those elements possessing low coefficients must be considered upper limits.* Taking into account the objection to drawing a slope through points possessing low ΔH values, the best slope that one can draw in all fairness to the data is one yielding a temperature of the order of 3,000° C. It was our intention to point out only that this is of a reasonable order of magnitude and is consistent with the other points of our argument.

Meteoritic data in their present form are both too crude and too sparse to permit the development of a quantitative proof on chemical grounds alone of the

V. M. Goldschmidt (*3*) was the first to recognize that nickel content of troilite is in reality quite low ~0.1%). Previously determined high values were obned probably due to contamination of the troilite by reibersite.

relationships between meteoritic matter and the earth. In particular, one cannot base conclusions (either pro or con) concerning the planetary origin hypothesis on the basis of an isolated consideration, such as Prof. Klotz has attempted. If this were possible, the planetary origin theory would long ago have been completely discounted on the very real and serious astronomical ground that it is difficult to understand how a single body in our solar system could have been shattered into pieces of meteorite dimensions. Rather, the field of meteoritics is like a complicated mosaic in which the various component parts must be pieced together into a reasonable pattern, and then examined for consistency. We found that on the basis of isting data, from the chemical point of view the pla tary origin hypothesis is consistent, as distinct fr other hypotheses we examined in the same light.

Much chemical data must be accumulated before can say definitely that meteorites did or did not h their origin in a planet. It is difficult to believe t on the basis of existing data, the hypothesis can refuted. However, with the development of new me ods for studying meteorites (*1*), the time should be too far distant when precise distribution coefficie are available together with adequate information distribution coefficients as a function of temperat

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TECHNICAL PAPERS

An Alternative Method for the Culture of *Sciara* Larvae

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In the course of a study of chromosomes with the electron microscope it became advisable to have in the laboratory stock cultures of the so-called fungus gnat, genus *Sciara*. Certain features of the salivary gland of the larva of this insect made its culture desirable for this work. The following method of culture developed in our laboratory seemed to be somewhat more satisfactory than that which had previously been described (*1*). In the earlier method the food supply was largely powdered dry yeast and powdered dry mushrooms, whereas in this method it is a living fungus.

The first step in the procedure is to initiate the growth of the fungus culture. The customary half-pint milk bottles were filled to a depth of about 1½″ with Sabouraud's media. After autoclaving, the media was slanted before cooling to provide more surface for the fungal growth which served as food for the developing larvae. The agar surface was then streaked with the fungus material. Pure cultures[2] of the genera *Haplosporangia*, *Allescheria*, and *Chaetoconidia* were used. All of them provided a satisfactory nutrition for the *Sciara* cultures, but somewhat better success was obtained with the *Chaetoconidia*.

The fungus was allowed to grow several days before the *Sciara* flies were introduced. By the time the larvae appeared, usually about 7 days after the flies were introduced, the fungus had formed a luxuriant mat over the media surface. Apparently most of the feeding is done in the larval stage, for the larvae feed voraciously on the fungus, which then begins to disappear. The growth of the fungus is adequate to provide food throughout the larval stage. The life cycle of the *Sciara* flies occupies about a month, the egg stage taking 5–6 days; larva, 14–15 days; pupa, 3–4 days; adult, 5–8 days. A new fungus culture is necessary for each new generation of flies, and therefore the fungus culture must also be maintained in stock on the Sabouraud media.

The *Sciara* cultures can be kept in the laboratory at ordinary room temperatures provided the temperature does not rise above about 29° C, since it is known that a higher temperature is lethal if maintained for more than a short time (*1*). The larval stage is particularly sensitive to heat, and if it is convenient, the cultures should be kept in an incubator at 22°–24° C.

The advantages which this method seems to offer over the previous one are: (1) a greater biological constancy in the nature of the food supply, (2) elimination of the necessity of repeated periodic feedings during the larval stage and (3) greater ease in maintaining an adequate moisture supply.

[1] The technical assistance of Mr. Sam H. Stone is gratefully acknowledged.

[2] The initial fungus cultures were kindly provided by Prof. O. A. Plunkett, Division of Botany, University of California, Los Angeles.

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Discontinuities in Properties of Water as a Function of Temperature

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It was shown by the author long ago (*1*) that a plot of the densities of many liquids vs. temperature gives a curve that is not smooth, but exhibits inflection points, or kinks, at some intervals. This can be shown to be true for any liquid for which there exist accurate experimental data. But water seemed an exception since the temperature-density curve is perfectly smooth according to figures given in tables used at the present time.

These kinks are often ignored, one reason being that they are not predictable on the basis of current theories. Another is that the previous experimentalists were not aware of them and performed the measurements of densities at regular intervals of temperature. But the kinks, or places of deviation from the smooth path, frequently fall between the observed points, and thus remain unnoticed. Some may attribute these effects to conditions which cause experimental errors of more or less systematic character. This view, in the light of the present data, seems absurd.

It would not be easy to repeat the work of Ramsey and Sydney Young (*3*) for this requires complicated apparatus and takes much time. But there is an easy method of demonstrating these phenomena at moderate temperatures (*2*). The density of propyl alcohol, which had been purified by the procedure of Sidney Young, was determined in a pycnometer at various temperatures between 20° and 80° C. The curve so obtained showed a kink in the same place as it had appeared in the data of Sidney Young. Other liquids also show kinks in this region of temperature, e.g. benzene at 45° C. The temperature was carefully regulated during these experiments, and, by weighing a 25-cc pycnometer, the density can be determined to five decimal places. But this is not

needed since the third decimal is sufficient to demonstrate the kinks. If the curve is plotted on graph paper in such a way that a fraction of a millimeter represents the fourth decimal place, the experimental errors are not seen at all. Any deviations from the smooth path must be due to intrinsic causes.

Of all substances known to the author, water seemed an exception in that it alone seemed free of these discontinuities. However, experiments performed recently

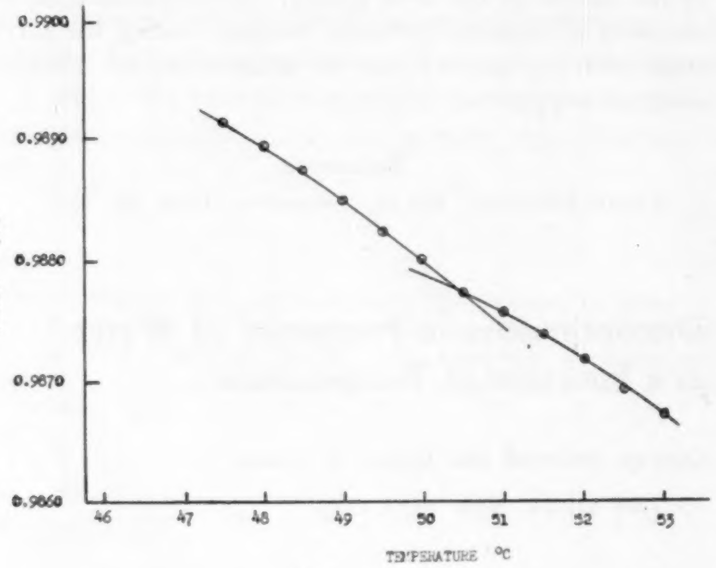

FIG. 1.

by the co-author show that this is not true, and that kinks are easily noticed in the density-temperature curve for ordinary distilled water. A 25-cc pycnometer was

FIG. 2.

used in these measurements, and densities determined for the range of temperatures from 47° to 53° C in a thermostat regulated to .002° C. There is a smooth stretch of the curve between 47° and 50° and another between 50° and 53°. These intersect just a little above 50° C, giving a well defined kink (see Fig. 1). Below 47 another smooth stretch of the curve begins, which is not shown on the drawing. Fig. 2 was drawn from the data given in the Smithsonian Tables. As may be seen, the graph is perfectly smooth with only a slight curvature.

There can be no doubt that the experimental results were smoothed by applying the generally accepted rules for drawing a representative curve amidst erratic points due to experimental errors. In this case, however, it is not legitimate to do so because, as explained, the effect is well above the limits of experimental errors, and, on a drawing of the scale shown, the errors do not appear.

This is not the only case in which the figures given in tables are adulterated. There are some instances, especially in the study of liquids, in which the entire experimental work ought to be done afresh.

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A Study of Gastric HCl Formation[1]

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The mechanism whereby parietal cells secrete HCl against a concentration gradient has previously been investigated in preparations of isolated gastric mucosa (*6–10*). In the present study a modification of earlier apparatus has been introduced to permit simple continuous measurement of pH difference across the wall of the isolated stomach of the rat. The experimental procedure entailed the opening of the abdominal wall under barbiturate anesthesia and the injection, into the exposed stomach, of chilled phosphate buffer at pH 7.4. The entire stomach was then removed, opened along the lesser curvature, and rinsed with several changes of the solution with which the apparatus was to be filled. The rugated portion of the stomach was so clamped between the smoothly ground faces of two half-cells (Fig. 1) that it served as a membrane separating the apparatus into two compartments. Ten ml of solution (see below) was then pipetted into each half-cell and a glass electrode immersed on each side. O_2 saturated with water vapor was bubbled through both sides to effect oxygenation as well as mixing. The potential difference generated between the two glass electrodes was read on a Beckman pH meter (Model H). More stable readings were obtained when the cell was placed in a grounded metal box and the housing of the meter was grounded. It was repeatedly observed that the pH difference, as computed from the total potential difference, and as calculated from individual determinations of pH on both sides of the membrane, agreed within 0.2 pH unit. With the development of a pH difference, it was invariably found that the solution in contact with the mucosal surface became acid and simultaneously the solution in the serosal compartment became alkaline.

In every experiment the solutions introduced on both sides of the membrane were initially identical, and when

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agents were added in the course of an experiment, similar additions were made to both compartments. The standard solution employed was a modified, lightly buffered Kreb's solution (*14*) in which the concentration

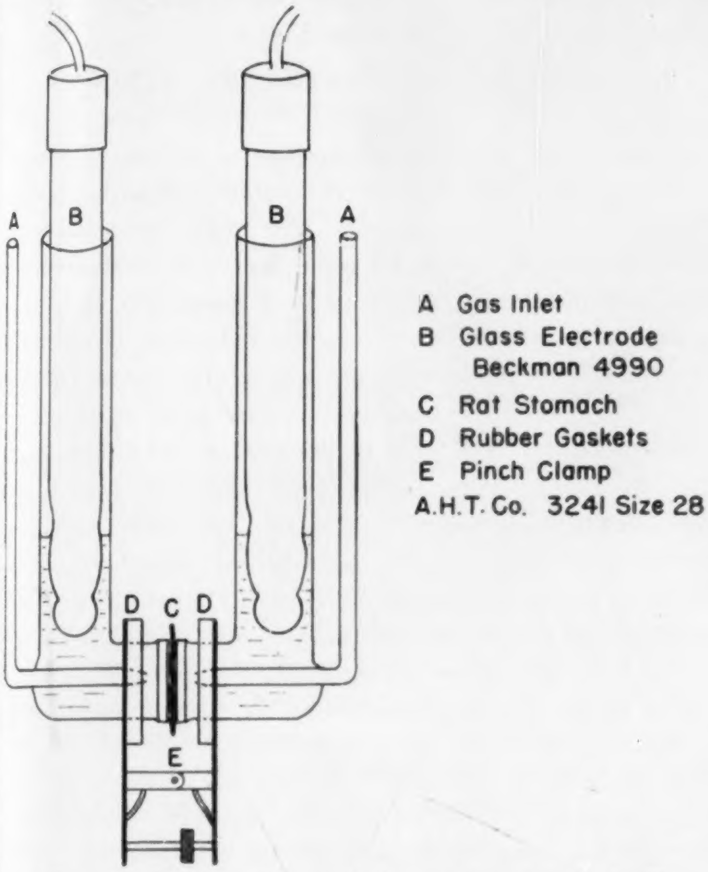

FIG. 1. Cell for the continuous measurement of pH difference across gastric wall.

of phosphate was reduced to approximately physiological levels (942 ml of 0.9% NaCl; 38 ml of 1.15% KCl; 10 ml of 1.18% $MgSO_4$; 13 ml of isotonic phosphate buffer at pH 7.4; 2 gm glucose). Under these conditions, the observed potential difference increased over a period of 3 to 6 hrs from an initial value of approximately zero to a value of about 250 mv, corresponding to a pH difference of about 4 units (Curve A, Fig. 2). Failure of development of a potential difference usually proved to be due to perforations in the membrane.

Successive elimination of the various ionic constituents from the medium revealed that acid production proceeded nearly as well in a medium of 0.9% NaCl solution as in the more complex media. In fact, in a medium containing only 5% glucose and no added salts, acid production proceeded actively for about one hour. It was further found that the presence or absence of glucose in the standard medium had no effect upon the capacity to generate acid, a finding which is attributed to the presence of intracellular nutrient adequate for the duration of the experiment.

In accord with observations of others (*7, 9*), continuous oxygenation of the fluid in the mucosal compartment was found to be essential to prolonged acid production. Interruption of the stream of O_2, or its replacement by N_2 (Curve B, Fig. 2), resulted in a decrease in the rate of acid secretion, although characteristically this decrease was not marked until 15 or 20 min of anoxia had elapsed. Reoxygenation after a period of 40 to 60 min of anoxia resulted in a limited degree of resumption of acid formation. Here again a short time lag was noted.

In agreement with reports in the literature (*15*), a high degree of inhibition of gastric acid formation was obtained with cyanide (0.0003 M) (Curve C, Fig. 2), fluoride (0.01 M), arsenite (0.001 M), and iodoacetate (0.003 M). In addition, tetramethyl *p*-phenylenediamine, reported to inhibit pyridine nucleotide systems (*12*), was found to poison in 0.002 M concentration. Histamine (0.005 M) gave an inconstant stimulation of acid production, while Benadryl (0.004 M), malonate (0.01 M), and phlorhidzin (saturated solution) were without demonstrable effect.

To account for the above experimental results as well as many observations by others, a hypothesis is offered for the mechanism of gastric HCl formation. Consideration has been given to the following additional and pertinent facts: carbonic anhydrase (*2, 3*) and niacin-containing coenzyme (*1*) are abundantly present in the

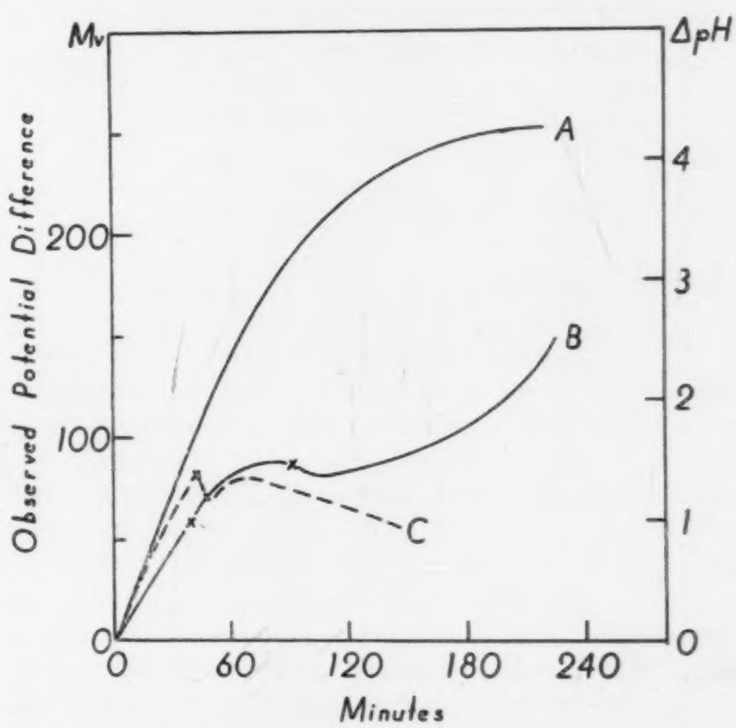

FIG. 2. The development of pH difference across the rat gastric wall. Curve A, standard preparation; Curve B, O_2 replaced by N_2 during interval x – x; Curve C, KCN (0.0003 M) added at x.

parietal cells; niacin deficiency results in hypochlorhydria (*17*); during periods of HCl secretion the venous drainage of the stomach is enriched with regard to $NaHCO_3$ (*5, 11*); an electrical potential difference between inert electrodes, wherein the mucosa is negative to the serosa in an external circuit, exists across the gastric wall (*16*). Thus chemically and electrically, as well as histologically, the cells under consideration are clearly oriented, and it is suggested that this orientation is a reflection of intracellular stratification of the several enzyme systems, in contrast to a condition in which the enzyme systems are well intermixed. The postulated arrangement of the enzyme systems concerned is roughly diagrammed in Fig. 3.

The simplest picture that will account for the secretion

of HCl against a concentration gradient is that, at the expense of energy derived from the oxidation of some carbohydrate intermediate, RH_2, a local high concentration of hydrogen ions develops at some point close to the gastric lumen. Thence, by diffusion, HCl enters the gastric juice. An obvious and abundant source of hydrogen ions is the oxidation of RH_2 by a pyridine nucleotide coenzyme (cf. Fig. 3). The assignment of the site of reversible hydrogenation of pyridine nucleotide to the *ortho* double bond of pyridine is in fact based upon the

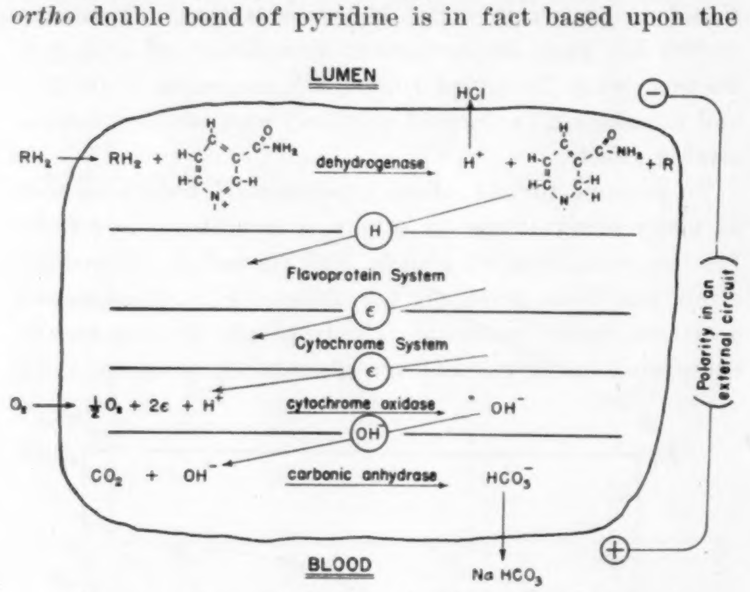

FIG. 3. Postulated stratification of enzymes in parietal cell and mechanism of HCl formation.

appearance of an extra mol of acid during its reduction (*12*, *18*), and we offer the postulate that this reaction is the actual source of the hydrogen ions in the present process. Adjacent to the pyridine nucleotide enzyme system, flavoprotein, cytochromes, and cytochrome oxidase may be pictured as lying in successive strata, with carbonic anhydrase intervening between the cytochrome oxidase and the vascular border of the cell. The hydrogen atoms which accumulate on the pyridine nucleotide as it is reduced by RH_2 can then be passed on to the adjacent flavoprotein, which can serve as a reductant of the neighboring cytochromes. Utilizing electrons supplied to it by cytochrome, cytochrome oxidase can now catalyze the formation of hydroxyl ions from gaseous O_2. Whereas in a less oriented system these hydroxyl ions are doubtless neutralized by hydrogen ions arising from the reduction of pyridine nucleotide, in the present hypothesis this neutralization is precluded by the anatomical remoteness of the two processes; instead, the accumulating hydroxyl ions are "detoxified" by reaction with CO_2 in the presence of carbonic anhydrase. The HCO_3^- thus formed diffuses into the blood stream as $NaHCO_3$. Note that in this picture Na^+ and Cl^- do not participate but merely passively accompany the other ions in their diffusions (*4*).

The present hypothesis accounts for the obligatory aerobic nature of the process of HCl formation, the dependence of the process upon dietary niacin, and the difference in electrical potential across the secreting gastric wall. It assumes stoichiometrical equivalence of the HCl secreted into the lumen and $NaHCO_3$ discharged into the venous blood, an equivalence recently demonstrated experimentally by Davies (*5*), and it permits the Q_{HCl} to exceed the Q_{O_2} by a factor of as much as 100%, which is also in accord with observations of this author. These relationships become apparent if one considers the over-all balanced expression for the sum of the several reactions postulated in Fig. 3:

$$2\ RH_2 + O_2 \ +2CO_2 \ \rightarrow 2R + \underset{\leftarrow}{2H^+} \ + \underset{\rightarrow}{2HCO_3^-}$$

The hypothesis finds further support in the observed high concentrations of pyridine nucleotide and carbonic anhydrase in the parietal cells. No novel reactions have been postulated, but rather some degree of lamination of well-known enzymes, resulting in a separation of hydrogen ions known to arise from the reduction of pyridine nucleotide and hydroxyl ions which arise from the reaction of reduced cytochrome oxidase with oxygen.

Histochemical attempts to demonstrate the postulated stratification of enzymes have thus far not succeeded, nor have attempts to assemble synthetic acid-secreting membranes along the lines of the foregoing hypothesis. The identity of the hydrogen donor, RH_2, is at present undetermined, but it may be pointed out that any or all substrates susceptible of oxidation by pyridine nucleotide could satisfy the requirements of the present hypothesis.

Thus, a hypothesis for gastric HCl formation is offered, predicated upon two basic assumptions: that the H ions of the gastric juice arise from the reduction of pyridine nucleotide; and that the enzymes of the oxidation-reduction systems in the parietal cell are arranged in successive strata. The hypothesis which follows from these assumptions appears to be in accord with all pertinent facts relating to gastric HCl formation.

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Deposition and Simultaneous Concentration of Dilute Solutions in Paper Partition Chromatography

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In adapting partition chromatography to the identification of histamine in extracts of biological materials, it became evident that the deposition of the customary 0.01 to 0.1 ml volume of fluid to the paper strips would not provide adequate amounts of histamine. The concentrations of histamine encountered were too low relative to the sensitivity of the color reaction employed as indicator

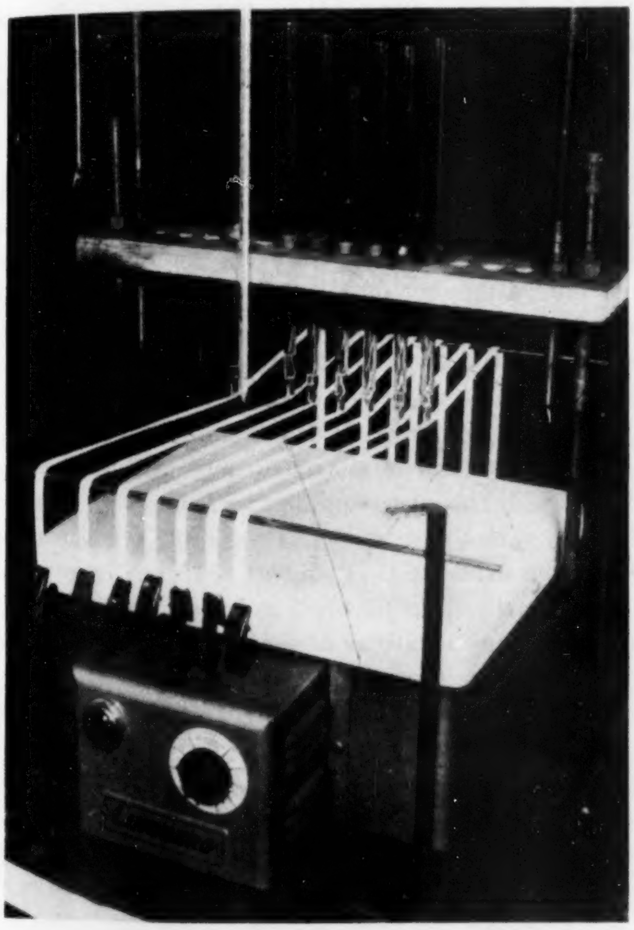

FIG. 1.

in the developed chromatogram. Therefore, it became necessary to deposit the entire final extracts, consisting of 3–5 ml of butanol, without allowing excessive spreading of the solvent on the strips.

Various procedures were tried, such as application of the solutions from very fine capillaries, pipettes plugged with cotton, and pipettes with sintered glass tips with and without simultaneous drying of the solvent with heat and by air blast. Since uniform delivery could not be obtained by any of these methods, the following procedure was finally chosen as most satisfactory.

The paper strips, cut to the proper length and marked at the point of application, are stretched horizontally above a hot plate. Both ends of the strips are weighted by means of window display hooks. Capillary pipettes are brought into contact with the application points marked on the strips. The pipettes are inserted through holes in a rack and held by means of rubber sleeves cut from pressure tubing (Fig. 1). The solutions to be

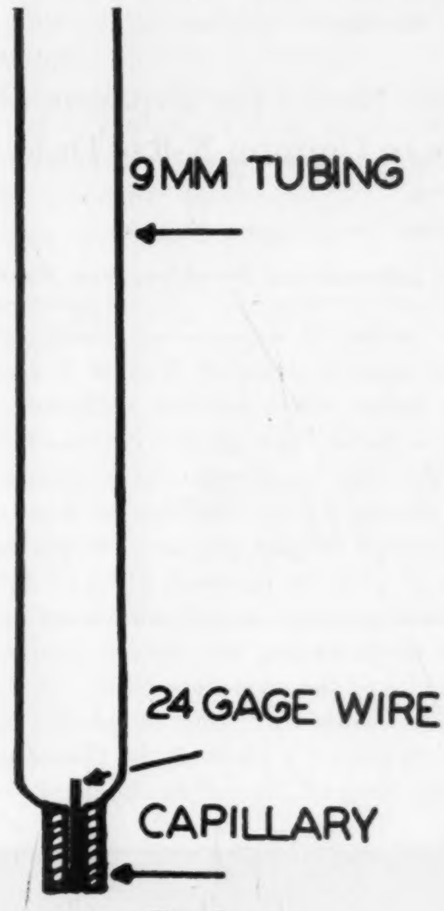

FIG. 2.

applied to the paper strips are transferred to the pipettes when the temperature at the level of the strips has reached the desired point. For our particular purpose, the pipettes are constructed of 9-mm Pyrex tubing, approximately 20 cm long. To one end an 8-mm length of capillary tubing is fused. The bore of the capillary is of such caliber that it will just admit a 10–12-mm length of 24-gage stainless steel or platinum wire (Fig. 2).[1] With this arrangement, approximately 1 ml/hr of butanol is delivered to and evaporated from the strips at a temperature of 60–70°. The assembly shown in Fig. 1 allows the simultaneous application of solutions to 14 strips with a minimum of attention. The wet spots on the strips spread no more than 2–3 cm at any time. The rate of delivery can be decreased by making the capillary longer or by using less liquid in the wide part of the pipette. After use, the wires are removed from the capillaries by pushing them out with a glass rod inserted through the 9-mm tubing, and the pipettes cleaned by letting them stand in alkaline cleaning solution.

Other organic solvents, such as ether, acetone, alcohol, dioxane, etc., can be applied in a similar manner. Aque-

[1] The pipettes were kindly suggested and made by J. J. Svarz, Department of Chemistry, Northwestern University Dental School.

ous solutions tend to spread excessively on the paper. Solutions containing even weak hydrochloric or sulfuric acid char a variety of the papers tried, even at moderately elevated temperatures. The method may prove useful in other applications of partition chromatography where the concentration of the substance to be identified is low in relation to the sensitivity of the color or other indicator reactions.

A Simple Device For Exposure of Groups of Mice to Uniform X-Ray Doses[1]

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In the course of experiments involving exposure of groups of mice to doses of X-rays[2] it was necessary to utilize a holder which assured uniformity of exposure. Based on a metal "pie plate" device of Snyder (*1*, *2*), this device was constructed to minimize the possible errors in dosage due to reflection of X-rays and interference in passage through the metal screen cover.

Circles of ¼″-thick plywood, 5½″ and 7½″ in diameter, were cut and enclosed in a 2″-wide strip of ¼″-mesh wire hardware cloth, so that the wooden plaque was mounted in the middle of the wire cloth band. A cover of plastic screen mesh, ordinarily used in window screening, was made by stretching a piece of the plastic mesh across an embroidery hoop of the proper diameter. (See Fig. 1.)

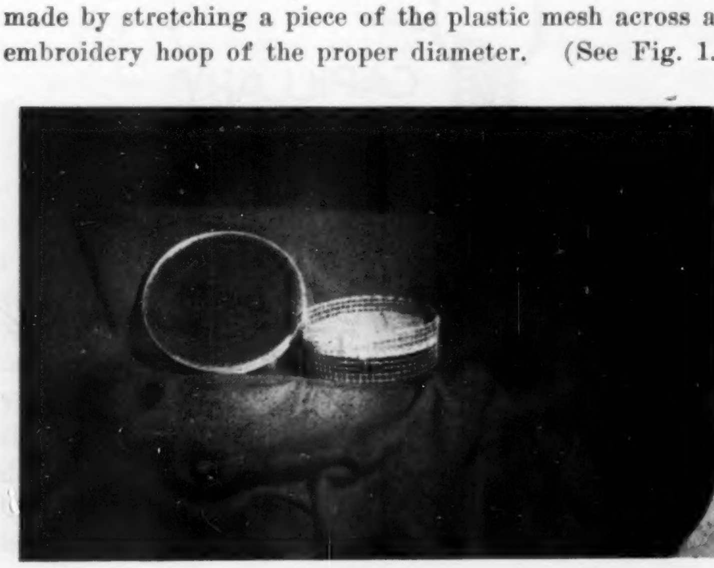

FIG. 1.

In such a device the X-rays do not pass through any metal before reaching the animals, thereby avoiding adulteration of the beam with secondary radiations. The plywood "floor" of the device is elevated 1″ above the table; thus there is a minimum of back scatter. Twenty-four mice can be simultaneously irradiated in the 7½″ tray and ten to fourteen mice in the 5½″ tray.

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2. Personal communication.

[1] Designed in connection with radiation study under Atomic Energy Commission and Office of Naval Research contract.

[2] By Milton Friedman, radiologist, New York University.

Infrared Spectrometry in Metabolic Studies With Deuterium-labeled Steroids[1]

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Infrared spectrometry, which has been of the greate[st] utility for the detection, identification, and isolation [of] steroid metabolities excreted in urine (*2*, *3*, *6*), has be[en] extended to the identification of steroids with deuteri[um] in the molecule. Changes in the infrared absorpti[on] spectra as a result of the replacement of hydrogen [by] deuterium were noted first by Hardy, Barker, and De[n]nison (*4*) in 1932. The analysis of deuterium-containi[ng] organic compounds of biological interest by means [of] infrared spectrometry has since been described by Herg[et] and Hardy (*5*). Our investigations have been concern[ed] with the detection of a deuterium steroid in an extr[act] containing a number of closely related compounds. O[ne] marked advantage of the spectroscopic technique, esp[e]cially in physiological studies, is that the material to [be] examined can be recovered without loss or alteration. [It] is thus possible to employ deuterium as a tracer where [a] pure compound can be obtained only in limited amou[nts].

In Fig. 1 the spectrum of pregnanol-3(α)-one-20 [is] compared with the spectrum of the same compound wh[en] a hydrogen atom at C-11 and at C-12 has been repla[ced] by deuterium. Two absorption bands attributed to t[he] C-D stretching vibrations appear at 2,165 and 2,145 cm[⁻¹] in the deuterium-containing compound. In the neighbo[r]hood of 1,200 cm⁻¹ pronounced differences are appar[ent] in the two spectra. These latter differences can be a[s]cribed to the perturbing effect of the increased ma[ss] of the deuterium atoms on the molecular vibrations. [In] general, with an increase of the number of deuteri[um] atoms in a steroid there is a progressively greater chan[ge] in the spectrum between 700 and 1,300 cm⁻¹, as well [as] an increase in intensity of the bands at 2,165 and 2,1[45] cm⁻¹. These observations are expected since it has be[en] shown that the spectrum in the region 700–1,300 cm⁻¹ [is] extremely sensitive to any change in structure (*3*).

The C-D absorption bands in the neighborhood of 2,1[50] cm⁻¹ are particularly useful for the identification of [a] deuterium-containing molecule because, in the concentr[a]tions used, this region is transparent in the absence [of]

[1] Aided by grants from the American Cancer Society [on] recommendation of the Committee on Growth of the Nati[onal] Research Council), Ayerst, McKenna and Harrison, Ltd., [the] Jane Coffin Childs Memorial Fund for Medical Research, [the] Commonwealth Fund, the Anna Fuller Fund, the Lillia [Ba]bitt Hyde Foundation, the Albert and Mary Lasker Found[a]tion, the National Cancer Institute of the National Instit[utes] of Health, U. S. Public Health Service (grants C322 [and] C440) and the New York Foundation.

deuterium. For this reason increased amounts of the nonisotopic steroid in the sample do not interfere with the detection of deuterated molecules. Absorption in this region not only affords a positive indication of the presence of deuterium in the molecule but forms the basis for quantitative determination of the percentage excess of isotope in the sample. The only effect of dilution with a nonisotopic compound is to increase the total weight of the steroid which must be examined. As an illustration of the sensitivity of infrared analysis, the presence of deuterium could be established in as little as 25 μg of pregnan-11,12-d$_2$-ol-3(α)-one-20 containing five atoms percent excess of the istotope. This was accomplished with a microcell (*1*) of thickness of 3 mm and a volume of 0.04 ml of carbon tetrachloride as solvent. Changes in the spectrum were measured in both the 2,150 cm^{-1} and 700–1,300 cm^{-1} regions. The presence of a C-D bond in a series of different steroids has been established and using thicker microcells, even smaller quantities of substance suffice for estimation.

The usefulness of this analytical method has been demonstrated in the following metabolic experiment. Allopregnan-5,6-d$_2$-ol-3(β)-one-20-acetate was injected into a normal woman. After collecting the urine for 20 days, fractionation was effected by the procedures which have been described (*2*, *3*, *6*). Feces collected during the experimental period were studied in analogous fashion. An examination of the region of the spectrum in which the C-D stretching bands occur demonstrated that the isotope was present in both the crude α- and β-hydroxy ketonic fractions as well as in the α- and β-hydroxy non-ketonic fractions from both urine and feces. No such bands were detected in the neutral nonketonic-nonalcoholic fraction. Chromatographic separation of these crude fractions resulted in the separation of several crystalline compounds together with several amorphous fractions or mixtures. These are being investigated further, and the results will be reported in detail at another time. Nevertheless, since certain fractions exhibited strong C-D bands near 2,150 cm^{-1} while others either lacked these bands or had bands of a very low order of intensity, it was possible to locate rapidly the metabolites containing deuterium among the many substances excreted by a normal individual. It was further possible to establish the approximate deuterium content of these metabolites.

It is anticipated that metabolites of the steroid hormones will frequently be obtained in amounts so small that, without some prior knowledge of the approximate isotopic content, analysis by means of the mass spectrometer would be either difficult or impossible. It appears from these results that infrared spectrometry especially in physiological investigations will be a valuable supplement in the detection, analysis, and identification of deuterium compounds.

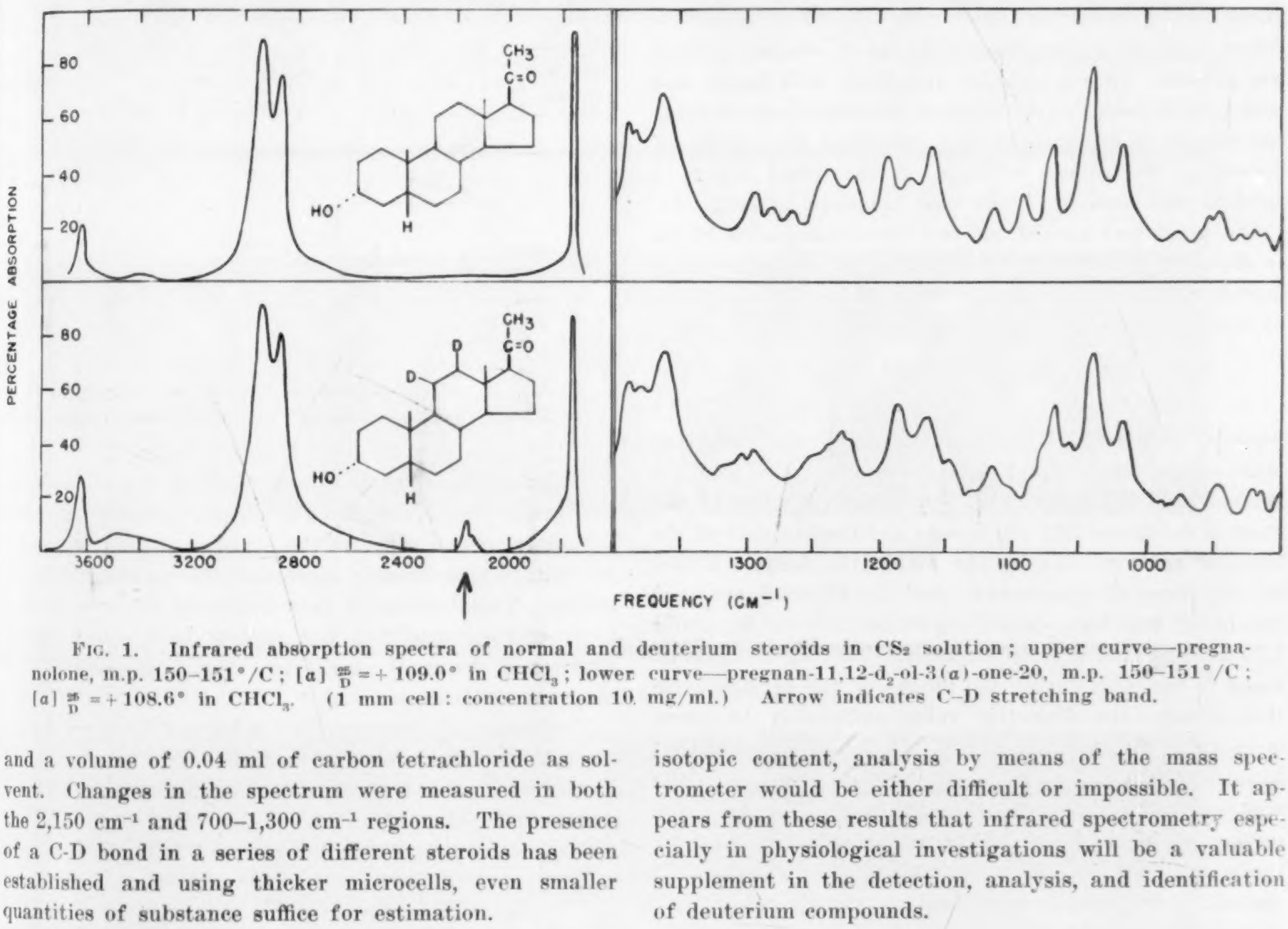

FIG. 1. Infrared absorption spectra of normal and deuterium steroids in CS_2 solution; upper curve—pregnanolone, m.p. 150–151°/C; $[\alpha]^{25}_{D} = +109.0°$ in $CHCl_3$; lower curve—pregnan-11,12-d$_2$-ol-3(α)-one-20, m.p. 150–151°/C; $[\alpha]^{25}_{D} = +108.6°$ in $CHCl_3$. (1 mm cell: concentration 10 mg/ml.) Arrow indicates C–D stretching band.

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The Use of Change in Capacity to Record Cardiac Volume in Human Subjects[1]

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A completely satisfactory method of determining cardiac output in man has not yet been devised. The direct Fick procedure and the various concentration methods, while theoretically sound, require considerable technical ability and facilities and are not applicable in the average laboratory or clinic. The ballistocardiograph, having the advantage of technical simplicity, is open to criticism on theoretical grounds and cannot be applied in situations where tachycardia or abnormal types of cardiac ejection are present. In a search for a method, both simple and widely applicable, we have begun investigations utilizing the change in capacitance of a condenser as a means of recording the volume changes of the intact heart; a method first used by Atzler and Lehmann in 1932 (*1*).

The condenser consists of two aluminum plates 15 cm in diameter placed before and behind the thorax so as to include the cardiac region in their field. The capacity of such a condenser is given approximately by:

$$C = 0.0885 \frac{AK}{K (D-T)} + T$$

where C = capacity; A = area of plates; K = dielectric constant of the chest; D = distance between plates; and T = thickness of the chest (*2*). The dielectric value of the chest is determined by the tissues and tissue fluids of the thoracic contents and by the air in the lungs. Under the conditions of measurement used, the dielectric constant for blood has been shown experimentally to be about 1.75 as compared with 1.00 for air. Varying amounts of blood in the field during the phases of the cardiac cycle thus change the dielectric value sufficiently to cause measurable changes in capacity. It should be noted that blood in the auricles and great vessels as well as in the ventricles contributes to these changes. In addition, movements of the heart will cause some change in capacity by moving blood closer or farther from the condenser plates, and respiratory movements of the chest wall will, likewise, produce capacity changes.

Atzler and Lehmann (*1*) placed their condenser in a resonant circuit, excited by an oscillator near its resonant frequency and connected to a diode detector. Thus, changes in capacity which would shift the frequency of the resonant circuit from that of the oscillator caused a change in the output of the diode which was amplified and recorded on a string galvanometer. A plot of output versus frequency for such a detector reveals a linear relationship over only a small region of the curve, resulting in difficulties of adjustment. To overcome these, we have used the frequency modulation discriminator to convert the changes in frequency to a measurable form. This has the advantage of simple adjustment and linearity of response, and allows the use of a limiter circuit to prevent amplitude changes from affecting the output.

The condenser is used as a portion of the frequency-determining circuit of an oscillator, the output of which is amplified by a broadband, high frequency amplifier and then by a pentode with low plate and screen voltages so

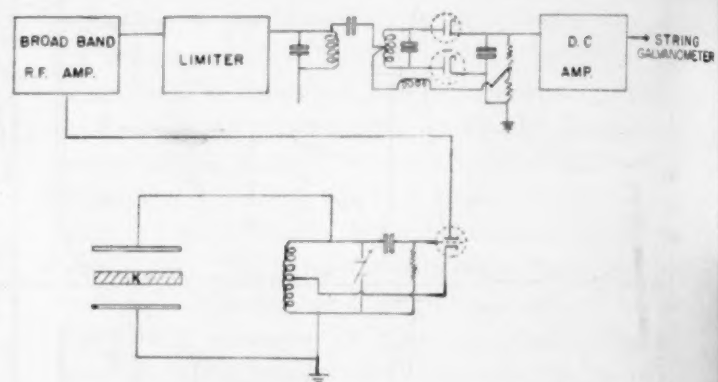

FIG. 1. Block diagram of circuit for recording capacitance changes accompanying the cardiac cycle.

that limitation of output with freedom from amplitude changes is accomplished. The output is fed to the discriminator which converts the changes in frequency to a d-c voltage that linearly represents the capacitative variations. This voltage is then amplified by a push-pull, direct-coupled amplifier and applied to a string galvanometer of the usual e.k.g. type. Fig. 1 presents a block diagram of the apparatus.

The choice of frequency is determined by several considerations. The chest is a poor dielectric substance and loss current as well as capacitative displacement current will be present.

The derivation from Roberts and Von Hippel (*3*) shows that the power factor $(\tan \delta) = \frac{\sigma}{\omega K}$; where σ is the conductivity of the medium, K is the dielectric constant and ω is the angular frequency. At low frequencies $\tan \delta$ is large and the loss current is maximized. At high frequencies not only are the power factor and loss current minimal, but a greater shift in frequency for a given change in capacity is present, with a resultant larger output. However, at ultrahigh frequencies absorption of the oscillator's energy takes place. As a compromise, for simplicity of circuits, we have chosen a frequency of 10.7 megacycles.

The apparatus is simple in adjustment and operation and gives consistent and reproducible records in both model and human experiments. Representative "cardiodielectrograms" of normal human subjects are pictured

[1] Preliminary reports covering this work were presented at the Fall Meeting of the American Physiological Society, Minneapolis, Minnesota, September 16 and 17, 1948.

[2] The authors wish to acknowledge the assistance of Dr. Fred A. Hitchcock, Dr. Theodore Wang and Mr. George Jacobi during preliminary phases of this work conducted in the Laboratory of Aviation Physiology and Medicine, The Ohio State University, Columbus. They are also indebted to Mr. Craig Goodwin of the Department of Psychiatry, University of Illinois College of Medicine, Chicago, for helpful advice and the use of equipment in the course of the investigation.

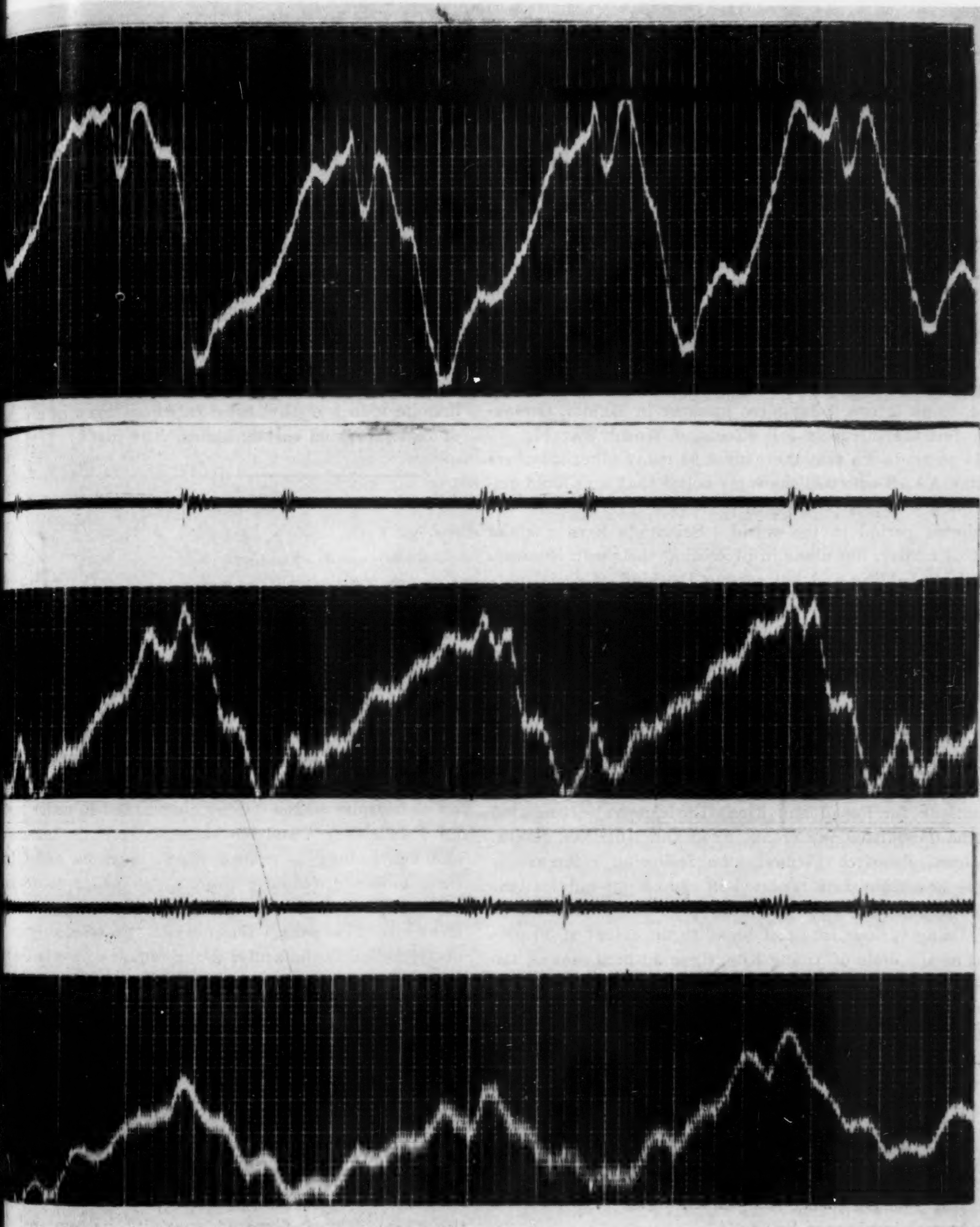

FIG. 2. Simultaneous recordings of phonocardiogram (above) and dielectrocardiogram (below) from normal hu-an subjects. Time intervals are 0.4 sec. Downward deflection indicates a decrease in the volume of blood in the field.

ig. 2. Values for stroke volumes, cardiac output, and iac indices calculated from such records on the basis eliminary calibration of the instrument by introduc- of known volumes of saline between the plates, fall in the range of accepted normal values, but conclu-s as to validity of the method are not yet possible.

nally, it is obvious that the method is basically applicable to the study of movements and volume changes in other regions of the body.

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Comments and Communications

In Praise of Chisholm's "Social Responsibility"

Dr. George Brock Chisholm's article "Social Responsibility" (*Science*, January 14, p. 27) merits more than the rather limited distribution afforded by *Science*. I am convinced there are many hundreds of intelligent nonscientists who would welcome these fundamental analyses of social phenomena that can lead to war.

Naturally, I am considerably interested in any intelligent means of preventing further destructive wars. I saw the beginnings of World War I in Berlin and London and, as an interned Japanese prisoner in Manila, personally felt the intensely evil effects of World War II.

It seems to me that there must be many other members of the AAAS who will share my belief that we should employ every means possible to prevent a return to another medieval period in the world. Scientists have a stake in this matter, not alone in protecting their own interests but in upholding and buttressing the kind of social pattern suggested by Dr. Chisholm, which is a workable plan and which means their survival.

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Concerning the Nutritive Value of Breads

In a recent publication (November 1948) entitled "Outlook for Bread and Flour Enrichment" (prepared by the Committee on Cereals, Food and Nutrition Board, National Research Council) the following reference is made to certain data reported in one of our publications (Guerrant and Fardig. *J. Nutrition*, 1947, **34**, 523).

"Using various forms of bread to the extent of 30 percent of the diets of young rats, these authors showed the following gains in weight during an 8-week feeding period: whole wheat bread, 82 grams; non-enriched bread, loss; enriched bread, 95 grams; dark bread, 15 grams; milk bread, 20 grams. An important feature of these experiments is that they illustrate the importance of the non-bread components in the dietary in determining the relative nutritional merits of the breads. The presence of 20 percent purified casein in all diets insured the presence of adequate protein for the high demand of young growing rats—much higher than those of slower growing human beings."

Inasmuch as the foregoing statements have led to a misinterpretation of our data, a word of explanation is hereby presented. To this end it seems necessary to point out again that the studies referred to above were concerned particularly with the various flours and breads made therefrom as sources of *thiamine* and *riboflavin*. This we attempted to make clear in the title and elsewhere in our publication. Since this point is not made clear in the report prepared by the Committee on Cereals, and certain pertinent details of our studies are not included, it is my desire at this time to emphasize that regarded growth rates reported as indications of relative *thiamine* and *riboflavin* content of the respecti breads, and only in these respects are they a measure the relative nutritive values of the breads.

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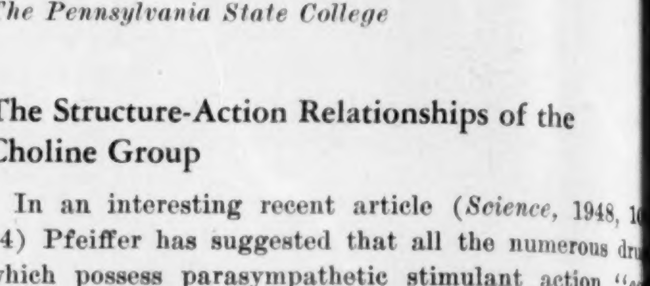
The Structure-Action Relationships of the Choline Group

In an interesting recent article (*Science*, 1948, 1 94) Pfeiffer has suggested that all the numerous dr which possess parasympathetic stimulant action "co tain a ketone oxygen group adjacent to an ether oxyg linkage with a methyl substituted nitrogen at a distan of two saturated carbon atoms," as in (I):



He assumes further that these three groups, carbon oxygen, ether oxygen, and N-methyl, are prosthet groups and proceeds to calculate from models the int prosthetic distances A and B. It may be noted in pa ing that this is an unusual use of the term "prosthetic which literally means "something added in order to ma up a deficiency" and has come to refer in immunolo and enzymology to groups which must be added to inert molecule (usually protein) in order to render physiologically active (e.g. antigenic or enzymically a tive); in this sense, the obvious prosthetic group acetylcholine is the acetyl group which converts the re tively inert substance choline into the highly pote parasympathetic transmitter. It would seem more f ting to refer to the three groups as pharmacological *active* or *pharmacodynamic* groups. But leaving as such niceties of terminology, it would indeed be welco if the complexities of the pharmacology of parasy pathetic drugs could be seen to have an underlying ba as simple as Pfeiffer suggests. Unfortunately, his a sumptions are beset with difficulties, of which two m be briefly considered: (1) not all molecules containi the three groups disposed spatially as required sho parasympathetic stimulant actions and (2) some molecu show such actions but do not contain all three group

(1) Not all choline esters of carboxylic acids are par sympathetic stimulants although they contain the thr groups at the appropriate mean distances apart. T extraordinary potency of the acetic ester compared wi that of its near homologues, such as the formic a propionic esters, is well known, but higher homologu e.g. the butyric and valeric esters, have scarcely a parasympathomimetic activity (H. C. Chang and J.

ddum. *J. Physiol.*, 1933, **79**, 255; R. Hunt and R. de Taveau. Bull. No. 73, Hygienic Laboratory, U. S. easury, 1911) and, when a phenyl nucleus is introed, as in the benzoic, phenylacetic esters, etc., the npounds appear to have purely nicotine-like properties Hunt and R. de M. Taveau. Bull. No. 73, Hygienic boratory, U. S. Treasury, 1911); the benzilic ester is opine-like (H. R. Ing, G. S. Dawes, and I. Wajda. *Pharmacol.*, 1945, **85**, 85). Similarly in the carbamic ers, alkyl substitution in the carbamyl group leads to sharp decline in parasympathetic stimulant actions ich are completely absent in the phenylcarbamic ester B. Bender, M. A. Spirtes, and D. B. Sprimson. *J. armacol.*, 1943, **77**, 107); the dibutyl- and diamylcarnic esters are atropine-like (K. C. Swan and N. G. hite. *Amer. J. Ophthal.*, 1944, **27**, 933).

It may be argued, and probably with justice, that the ergence of atropine-like properties in the benzilic and utylcarbamic esters means that these esters have an nity for parasympathetic endings but block the action acetylcholine. There would appear to be a gradation properties which pass through a stage when the esters e little or no affinity for parasympathetic endings and ither stimulate nor paralyze them; thus Swan and hite (K. C. Swan and N. G. White. *Amer. J. Ophthal.*, 44, **27**, 933) found in the dialkylcarbamic esters of line that the diethyl member was a weak miotic, the -propyl member inactive, and the dibutyl member was driatic. Similarly, the lower fatty acid esters of choe have stimulant effects at parasympathetic endings; nzoic, phenylacetic esters, etc. have no action, and nzilic and tropic esters paralyze them.

(2) The ethers of choline contain no carbonyl oxygen, t the simple alkyl ethers have well-established parampathomimetic properties; indeed Dale (*J. Pharmacol.*, 14-15, **6**, 147) noted that choline ethyl ether resembled scarine more closely than it did acetylcholine in that its otine-like effects were less prominent; the ethyl ether of ethylcholine is even more like muscarine and is a werful miotic. Finally, true parasympathomimetic ects, e.g. on the heart and blood pressure, are shown alkyltrimethylammonium salts which lack both the bonyl oxygen and the ether linkage (J. H. Burn and H. Dale. *J. Pharmacol.*, 1914–15, **6**, 417; R. Hunt. *Pharmacol.*, 1926, **28**, 367; R. Hunt and R. R. Renshaw. *Pharmacol.*, 1925, **25**, 315; 1926, **28**, 367).

It seems clear therefore that although the carbonyl ygen, ether oxygen, and N-methyl group occur in many rasympathomimetic drugs, these groups are not all inpensable and their presence in a molecule does not essarily ensure parasympathetic stimulant action.

One of the most interesting features of Pfeiffer's icle is the prominence which is given to the spatial ations of the so-called prosthetic groups. There is leed suggestive evidence that the actual molecular dinsions of members of the choline group have an imrtant influence on the potency of these drugs. Two mensional factors appear to be important: (1) the e of the "cationic head" of the molecule and (2) the gth of the chain attached to it.

(1) The most active members all contain the $\overset{+}{N}Me_3$-group as cationic head; there appears to be no exception to this rule. Successive replacement of methyl groups by either hydrogen or ethyl leads to a steep decline in parasympathomimetic activities (Table 1). The replacement

TABLE 1

$-\overset{+}{X}$	Mols AcO · $C_2H_4\overset{+}{X}$ = 1 mol acetylcholine		
	Cat's blood pressure	Rabbit intestine	Frog's heart
$-NMe_3$	1	1	1
$-NMe_2H$	50	> 40	> 50
$-NMeH_2$	> 500	> 1,000	> 500
$-NH_3$	> 2,000	20,000	40,000
$-NMe_2Et$	3	2.5*	2
$-NMeEt_2$	400	700*	1,500
$-NEt_3$	> 2,000	1,700*	> 10,000
$-PMe_3$	13	12	12
$-AsMe_3$	66	90	83

* These figures refer to guinea pig ileum.

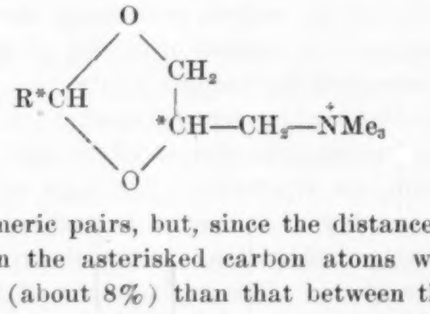
of one or more methyl groups by hydrogen (R. L. Stehle, K. J. Melville, and F. K. Oldham. *J. Pharmacol.*, 1936, **56**, 473) leads to relatively weak bases. The dissociation constants of these bases are not known, but they would not necessarily decrease in the order of successive replacement of methyl by hydrogen; nor if they did is it likely that they would decrease sufficiently steeply to account for the progressive decline in activity. No doubt both the instability of the cations containing one or more hydrogen atoms and the absence of methyl groups play their part in the observed decline in activity.

The successive replacement of methyl by ethyl groups does not produce so dramatic an effect until at least two methyl groups are replaced.[1] The high activity of the mono-ethyl member of the series is particularly interesting. A possible explanation of this observation will be discussed elsewhere. The replacement of three methyl groups by ethyl reduces the muscarine activity of the cation to negligible proportions; this effect of the triethylammonium group (and the similar effect of higher trialkylammonium groups) has also been observed in the analogous ethers (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1929, **37**, 309; 1933, **48**, 105), in betaine esters (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1933, **48**, 105), in tetra-alkylammonium salts (J. H. Burn and H. H. Dale. *J. Pharmacol.*, 1914–15, **6**, 417; R. Hunt. *J. Pharmacol.*, 1926, **28**, 367; R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1925, **25**, 315), and in Bovet's acetal compounds (formula II: E. Fourneau, D. and F. Bovet, and G. Montezin. *Bull. Soc. Chim. biol.*, 1944, **26**, 134, 516).

The replacement of the N-atom in acetylcholine by P or As (A. D. Welch and M. H. Roepke. *J. Pharmacol.*, 1935, **55**, 118) also increases the size of the cationic head of the molecule and leads to a decline in activity (Table 1); this result is interesting because the three methyl groups and the high basicity are retained. The change will, of course, increase the "interprosthetic" distances A and B in formula I, but only slightly.

[1] Unpublished work by Mrs. P. Holton in this Laboratory.

(2) If parasympathetic drugs of the general type $R-\overset{+}{N}Me_3$ are considered, it will be found that the most active member of any group of homologues will usually be the one containing a 5-atom chain (excluding hydrogen atoms) in the group R. In the esters, acetylcholine is much more active than either formyl- or propionylcholine[2]; similarly N-alkylcarbamylcholines are less active than carbamylcholine. Both the nitrous and the nitric esters of choline, which Dale (*J. Pharmacol.*, 1914–15, **6**, 147) found to have considerable muscarine activity, contain 5-atom chains, but the higher and lower homologues have not been studied; the former compound was for many years called "synthetic muscarine." Pyruvylcholine (H. C. Chang and J. H. Gaddum. *J. Physiol.*, 1933, **79**, 255), which contains a 6-atom chain, is moderately active, but its lower homologue, glyoxylylcholine, has not been studied. The acetic esters of formocholine ($HO \cdot CH_2 \cdot \overset{+}{N}Me_3$) and γ-homocholine ($HO \cdot CH_2CH_2CH_2\overset{+}{N}Me_3$) are both less active than acetylcholine (R. Hunt and R. de M. Taveau. Bull. No. 73, Hygienic Laboratory, U. S. Treasury, 1911). In choline ethers, the ethyl ether is more active than either the methyl or propyl ethers (H. H. Dale. *J. Pharmacol.*, 1914–15, **6**, 147). Similarly, in formocholine ethers, $RO \cdot CH_2\overset{+}{N}Me_3$, where R is CH_3, C_2H_5, C_3H_7, or C_4H_9, the most active member is the *n*-propyl ether (A. J. Ewins. *Biochem. J.*, 1914, **8**, 366). Bovet's compounds (II) are interesting; they should exist in



(II)

diastereoisomeric pairs, but, since the distance across the ring between the asterisked carbon atoms will be only slightly less (about 8%) than that between the α and γ carbon atoms in a normal chain, we can regard (II) when R is CH_3 as the nearest approach to the 5-atom chain type; in fact, the compound in which R is CH_3 is markedly more active than the compounds in which R is H or C_2H_5 (E. Fourneau, D. Bovet, F. Bovet, and G. Montezin. *Bull. Soc. Chim. biol.*, 1944, **26**, 134, 516).

In the alkyltrimethylammonium series, the *n*-amyl member was found by Raventos (*Quart. J. exp. Physiol.*, 1937, **27**, 99) to be the most active on the frog's auricle; lower members were less active, and higher members inactive or antagonistic.

There appear to be very few exceptions to this 5-atom chain rule.[3] Simonart (*J. Pharmacol.*, 1934, **50**, 1) recorded that the methyl ether of β-ethylcholine was a more powerful vasodilator than the ethyl ether, but the reverse was true of the corresponding ethers of β-methyl- and β-propylcholine. Hunt and Renshaw (*J. Pharmacol.*, 1932, **44**, 151) found that in the series of thioethers $RSCH_2\overset{+}{N}Me_3$ I, where R was CH_3, C_2H_5, C_3H_7, and C_4H_9, the *n*-propyl and ethyl ethers were about equally active vasodilators. Among betaine esters ($RO \cdot CO \cdot CH_2\overset{+}{N}Me_3$), the methyl and ethyl esters were also about equally active vasodilators (R. Hunt and R. R. Renshaw. *J. Pharmacol.*, 1925, **25**, 350; 1926, **29**, 17). Finally Kulz (*Arch. exp. Path. Pharmak.*, 1928, **98**, 337) found in the alkyltrimethylammonium series that the *n*-butyl member was the most active on the frog's heart.

This brief survey of the available data suggests that the actual dimensions of what we have called the cationic head and the chain in members of the choline group have an important effect upon the intensity of the action at parasympathetic endings; such a result seems to indicate that a fairly precise fit between the drug cation and some macromolecular structure in the living cell is required if a high degree of activity is to be observed.

We have so far been considering only the muscarinic properties of members of the choline group. It is unfortunate that the relations between structure and the nicotine-like actions of the group are much more obscure. There is some evidence that the size of the cationic head has an important effect upon the stimulant-nicotinic properties (e.g. on sympathetic ganglia) because they are diminished by replacing the N-atom of acetylcholine by P or As and abolished by replacing the three N-methyl groups by ethyl or larger radicals. Among onium salts also, only those containing three methyl groups attached to the central atom (N, P, As, or S) produce contracture of the frog's rectus abdominis (H. R. Ing and W. M. Wright. *Proc. roy. Soc.*, 1933, **114B**, 48). There are indications that particular radicals, e.g. *n*-butyl, benzyl, etc., intensify stimulant-nicotinic activity; thus the butyl ether of choline (A. Simonart. *J. Pharmacol.*, 1932, **46**, 173) and the methyl ether of β-butylcholine (A. Simonart. *J. Pharmacol.*, 1934, **50**, 1) both have striking nicotinic effects on blood pressure. It is generally assumed that β-methylcholine derivatives fail to show stimulant nicotinic effects; this appears to be frequently but not invariably true: thus, whereas the *n*-butyl ether of β-methylcholine, in contrast to that of choline, has only a slight pressor action after atropine administration, Renshaw *et al.* (*J. Amer. chem. Soc.*, 1938, **60**, 1765) found that acetyl β-methylthiocholine ($CH_3CO \cdot SCHMeCH_2\overset{+}{N}Me_3$) had an intense nicotinic effect on blood pressure not only after, but even before, the administration of atropine.

The paralyzing nicotine-like action on sympathetic ganglia appears to be, like the curariform action on striated muscle, a general property of "onium" cations. There is no evidence, however, that the paralysis of ganglion cells runs parallel with that of voluntary muscle; indeed, what evidence there is suggests a reciprocal relation—that high curariform activity is associated (in onium cations) with low paralyzing activity on ganglion cells and vice versa. Tetraethylammonium is the best known example of this inverse relation.

H. R. I

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[2] In the esters $C_nH_{2n+1}\ CO \cdot O \cdot CH_2CH_2\overset{+}{N}Me_3$ the chain length is $n+4$; i.e. formylcholine ($n=0$) has a 4-atom chain. If the carbonyl oxygen of formylcholine were regarded as part of a 5-atom chain, this ester would have to be compared with the formic esters of formocholine and γ-homocholine.

[3] We have neglected the small differences in length between 5-atom chains arising from the different atomic radii of C, O, and N because they would be insignificant in comparison with the differences in the lengths of homologous chains.

NEWS and Notes

The National Science Foundation. On February 25 the Senate Committee on Labor and Public Welfare reported out S. 247, "The National Science Foundation Act of 1949". On March 3 it was officially reported to the Senate in Senate Report No. 90, but there is no basis for predicting when it will come up for discussion or for vote.

The National Science Foundation Act of 1949 is in every detail the National Science Foundation Act of 1948 (S. 2385). Like the latter it is a nonpartisan bill sponsored by Senators Thomas, Kilgore, Fulbright, Magnuson, Smith, Cordon, and Saltonstall. With this sponsorship the Senate Committee feels confident that S. 247 will be passed without much debate and without amendment—possibly without a dissenting vote, as S. 2385 was passed in the spring of 1948. There is also definite reason to believe that the bill will receive the President's signature.

All this sounds very encouraging, provided S. 247 is the kind of legislation scientists want. In private, at least three of the sponsors frankly admit that they prefer a more liberal bill. One of them has expressed the hope that it will be amended in this direction in the House and has confessed that S. 247 was reintroduced into the 81st Congress without modification because it was the easiest course for the Committee to follow, and because this bill is virtually assured of passage.

It is also known that the President favors more liberal legislation, but he seems even more concerned that a National Science Foundation be created and hence will not oppose legislation which accomplishes this primary objective.

Although S. 247 has not yet passed the Senate, it looks as if the House will have the responsibility of determining what final form the National Science Foundation will take. Six bills are already before it and will be considered by the Committee on Interstate and Foreign Commerce, after this Committee is fully organized. Five of these bills (H.R. 12, 185, 311, 1845, and 2308) are similar to H.R. 6007 of the 80th Congress, and are thus like S. 247. One (H.R. 359), introduced by Congressman Celler, follows the pattern of S. 1850 of the 79th Congress. Although H.R. 359 is a liberal bill, it has serious shortcomings, and it may be questioned whether the Congress has before it any bill which provides a wholly satisfactory base for final legislation. Indeed, the House Committee is already receiving letters urging changes in the bills before it. The situation calls for serious study by the Nation's scientists.

HOWARD A. MEYERHOFF

About People

Alan R. Moritz has been appointed professor of pathology in the school of medicine of Western Reserve University, and director of pathology, University Hospitals of Cleveland. At present Dr. Moritz is professor of legal medicine at Harvard Medical School and pathologist-in-chief at Peter Bent Brigham Hospital. In his new post he will succeed **Howard T. Karsner,** who has been appointed Medical Adviser to the Surgeon General, U. S. Navy.

Emory N. Kemler has resigned as acting director of research for New York University to become associate director of Southwest Research Institute, Houston, Texas. Dr. Kemler succeeds **John V. Pennington,** on leave of absence from the Institute.

Ludwig Mies van der Rohe, head of the department of architecture at Illinois Institute of Technology, has been elected to honorary corresponding membership in the Royal Institute of British Architects. A native of Aachen, Germany, Dr. van der Rohe came to the United States in 1938.

Julian Huxley, whose term of office as director general of Unesco ended last December, has accepted an invitation of the British Minister of Education to become a member of the United Kingdom Unesco Committee.

Hagop H. Alexanian, chemical engineer, and **Kenneth C. Kennard,** organic chemist, have joined the staff of the Technical Command, Army Chemical Center, Maryland, in the munitions division and the chemical division respectively.

Ernest B. Babcock, professor emeritus of genetics, College of Agriculture, University of California at Berkeley, has been appointed president of the section of experimental taxonomy of the seventh International Botanical Congress, to be held in Stockholm, Sweden the summer of 1950. Three University of Michigan botanists have also been appointed to the Congress: **Chester A. Arnold** as vice president of the section for paleobotany, and **William Randolph Taylor** and **William C. Steere** as vice presidents of the section of taxonomy.

Beno Gutenberg, professor of geophysics and meteorology at the California Institute of Technology, has been made a corresponding member of the Royal Swedish Academy of Science.

C. Fred Gurnham, New Haven consultant engineer, has been appointed chairman of the Department of Chemical Engineering in the Tufts School of Engineering, Medford, Massachusetts, effective this month.

Donald J. Hebert, head of basic hydraulic research with the Bureau of Reclamation, Denver, Colorado, has been appointed associate professor of civil engineering at Columbia University. Professor Hebert will conduct experimental apparatus and research studies in addition to teaching hydraulics.

Cornelius E. Senseman, special assistant to the Chief of the Bureau of Agricultural and Industrial Chemistry, has retired after more than 30 years of Federal service. Mr. Senseman has played an active role in the chemurgic field.

The American Optical Company has appointed **Charles J. Burton,** formerly with the American Cyanamid Company, and **Walter A. Fraser,** of the Perkin-Elmer Corporation, to the staff of its newly established research laboratory in Stamford, Connecticut.

Harry L. Ebert has been appointed chief chemist of Firestone Industrial Products, Fall River, Massachusetts.

Herschel Weil, of Brown University, has joined the staff of General Electric Company, Schenectady, New York, as a mathematician.

Paul R. Needham has been appointed professor of zoology at the

University of California at Berkeley, where he will direct teaching and research in ichthyology and fisheries biology.

Percy L. Julian has joined the faculty of Fisk University as a consultant in research chemistry.

John J. Phair recently joined the staff of the University of Cincinnati's Department of Preventive Medicine and Industrial Health, succeeding the late **Thomas J. LeBlanc.** Dr. Phair had been chairman of the University of Louisville's Department of Preventive Medicine and Public Health since 1946.

Cushman D. Haagensen, coordinator of cancer teaching at Columbia University's College of Physicians and Surgeons, has been named director of the University's Institute of Cancer Research. Dr. Haagensen is also assistant attending surgeon and assistant surgical pathologist at the Presbyterian Hospital of New York City.

Stuart McLain, former associate director of the Technical Division at Oak Ridge National Laboratory, has recently joned the staff of the Argonne National Laboratory as a senior chemical engineer.

Hans Kohler, formerly a member of the Research Laboratories of the Signal Corps, is now with the National Bureau of Standards in the Electronics Division.

M. K. Goldstein, head of programs research, Office of Naval Research, has been granted leave of absence to serve as a senior technical staff member of the Air Navigation Development Board. On March 17 Dr. Goldstein will receive the Washington Academy of Science's 1948 Academy Award in the Engineering Sciences.

Visitors to U. S.

Yngve Öhman, head of the Stockholm Observatory, arrived here last month for a year's stay. At the invitation of Harvard University, he will study at the High Altitude Observatory in Boulder, Colorado.

Karl von Frisch, Austrian zoologist from the University of Graz, will be a guest of Cornell University's Zoology Department the last half of this month. The subjects of his public lectures there on March 16, 18, and 21, will be "The Color Sense of Bees," "The Chemical Senses of Bees," and "The Language of Bees." Dr. von Frisch will visit other U. S. universities and will return to Europe about June 1.

Stig Karlson, associate professor of obstetrics and gynecology at Stockholm, Sweden, was a recent guest of Clair Folsome, medical director of the Ortho Research Foundation, Raritan, New Jersey. Dr. Karlson, an authority on the physiology and pathology of the uterine musculature, visited the Lying-In Hospital of Chicago University and the New York Hospital of Cornell University's Medical School during his two-week stay.

Eugene E. Rabe, formerly of the University of Berlin, has been made assistant professor of astronomy in the University of Cincinnati's Graduate School of Arts and Sciences and College of Liberal Arts. He will continue work on the International Astronomical Union's minor planets program, with which he has been identified for more than 10 years. As a special project, he is studying the orbit of the planet Eros, discovered in 1898. Dr. Rabe spent some time at the U. S. Naval Observatory in Washington before going to Cincinnati.

Six Indian engineers recently arrived in this country for several months' training in the operating, maintenance, and production phases of fertilizer manufacturing plants. They are: **K. L. Ramaswami, J. Simon, H. G. Rao, H. A. Bhatta, S. C. L. Jain,** and **A. N. Krishna Swami.** Upon their return to India they will take over operation of a new $50,000,000 fertilizer plant at Sindri, 175 miles northwest of Calcutta. The plant, sponsored by the Indian Government, is now being operated by Chemical Construction Corporation, a unit of American Cyanamid Company.

Grants and Awards

The Society of Chemical Industry, London, has awarded its gold medal for 1949 to Foster Dee Snell, president of Foster D. Snell, Inc., New York firm of consulting chemists and engineers. Dr. Snell will receive the medal at the Society's meeting at Manchester, England, July 13, when he will deliver an address on a phase of surface activity.

Henry Eyring, professor of chemistry, University of Utah, recently received the Research Corporation of New York's achievement award, consisting of a plaque and $2,500.

The World Health Organization of the United Nations has been awarded a medal by the Egyptian Government for its action in stopping a cholera epidemic in that country in 1947.

The Alvey-Ferguson Company of Cincinnati has given Columbia University $20,000 to establish scholarships for students in the mechanical and electrical engineering departments of the School of Engineering.

Cornell University's Laboratory of Nuclear Studies has received a gift of approximately $1,000,000 from Floyd R. Newman, a director of Ashland Oil and Refining Company, of Cleveland. The laboratory, opened last October (see *Science*, October 8, p. 375), will be named for Mr. Newman.

Carl Eric Holmquist, a chemist at the Swedish Government Institute for Public Health, has received a grant from the Rockefeller Foundation to study technical hygiene for one year at Harvard University.

George B. Creamer of Syracuse, New York, has been awarded the Sylvania Division American Viscose Corporation Fellowship for the study of cellulose chemistry at McGill University, Montreal, Canada.

The Oberly Memorial Award, given every two years to the American citizen who compiles the best bibliography in the field of agriculture or the related sciences, is offered for 1949. The award is limited to publications issued during the calendar years 1947 and 1948. Those interested in competing should send four copies (either processed or printed) to Marvin A. Miller, Chairman, Oberly Memorial Award, University Libraries, University of Arkansas, Fayetteville, before June 15.

Colleges and Universities

The new biology building to be constructed on the campus of **West Virginia University** will house laboratories and classrooms for physiology, anatomy, genetics, embryology, cytology, bacteriology, plant pathology, taxonomy, and other specialized courses, as well as general courses in botany, zoology and biology. The completion date is set for November, 1950.

Members of the Division of Entomology and Parasitology of the **University of California** have organized a group to study the systematics and economics of plant- and animal-infesting mites. It is hoped that others who are interested in the same problems will cooperate in the projected program. Members of the initial group are: E. O. Essig, A. E. Michelbacher, W. W. Middlekauff, E. M. Stafford, F. M. Summers, A. D. Borden, N. W. Frazier, A. Earl Pritchard, G. L. Smith, W. Harry Lange, D. P. Furman, and L. M. Smith, chairman.

The University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital will dedicate the new wing of the hospital's psychiatric clinic March 31. Among those delivering addresses at the dedicatory program will be Paul Weiss, University of Chicago; Homer W. Smith, New York University; Howard Liddell, Cornell University; Lawrence S. Kubie, Yale University, and Clyde Kluckhohn, Harvard University.

The University of Georgia School of Medicine has opened a school of medical illustration and will offer courses, beginning this fall, for medical students, medical art students, and illustrators in other fields of science. Applications for admission may be addressed to the Registrar, University of Georgia School of Medicine, Augusta.

The Stanford University Research Institute recently opened its new precision gage laboratory to serve Western industry. Its equipment, most of it under contract from the Army Ordnance Department, which closed its San Francisco district gage laboratories in 1945, is capable of accurate measurement down to 25 millionths of an inch. Gage blocks (checked every six months with the National Bureau of Standards) and monochromatic light are used to determine the accuracy of machine parts. The laboratory also has a Magnaflux to test metals for cracks and flaws. All equipment is available to the public at nominal fees to be established on a cost-incurred basis.

The Western College Association will celebrate its 25th anniversary in Claremont, California March 26, and will honor its founder, James A. Blaisdell, former president of Pomona College and president emeritus of Claremont College. The Associated Colleges at Claremont — Pomona, Scripps, Claremont Men's College, and Claremont College—will be official hosts of the Association, which comprises 30-odd colleges and universities in California, Nevada, and Arizona.

Meetings and Elections

The New York University of Education is holding its annual **Health-Education Institute on Social Hygiene and Family Relations** this month, with morning sessions Monday to Friday through March 26.

The Annual **Seminar for the Study and Practice of Dental Medicine** will be held October 23–28 at the Desert Inn, Palm Springs, California. Discussion will be conducted by Arthur C. Curtis, University of Michigan, Wilton Marion Krogman, University of Pennsylvania; Seymour M. Farber, University of California Medical School; Balint Orban, University of Illinois; D. Harold Copp, University of California; Francis A. Arnold, Jr., U. S. Public Health Service; and Paul Popenoe, American Institute of Family Relations, Los Angeles. Detailed information may be obtained from Marion G. Lewis, Executive Secretary, 1618 Ninth Avenue, San Francisco 22.

The Second National Conference on Unesco will be held in Cleveland, March 31–April 2. Over 3,000 delegates are expected to attend the session, which is being called by the U. S. National Commission on Unesco, an advisory body to the Department of State. The principal speaker will be Jaime Torres Bodet, newly elected director general of Unesco.

The Michigan Academy of Science, Arts, and Letters, will hold its annual meeting at Wayne University, Detroit, Michigan, March 31–April 2. Eighteen special-interest groups within the Academy will share research findings in their fields. All interested persons are invited to attend.

The Division of Biological Chemistry of the American Chemical Society will conduct a **symposium on viruses** at the meeting of the Society in San Francisco, March 31. Papers on various aspects of recent virus investigations will be presented by Karl F. Meyer, director of the Hooper Foundation; Cyrus P. Barnum, Jr., University of Minnesota; Seymour S. Cohen, University of Pennsylvania; M. A. Lauffer, University of Pittsburgh; D. G. Sharp, Duke University; Robley C. Williams, University of Michigan; and eight Pacific Coast investigators. The symposium was arranged by W. M. Stanley, director of the Virus Laboratory, University of California at Berkeley.

The Medical Library Association will hold its annual meeting in Galveston, Texas, April 10–14. The Library of the University of Texas Medical Branch will be the host.

The annual Theobald Smith Memorial lecture of the **New York Society of Tropical Medicine** will be held on April 22 at 8:30 p.m., in the auditorium of the School of Public Health, Columbia University, 600 West 168th Street, New York City. Fred L. Soper, director of the Pan American Sanitary Bureau, will speak on "The 1949 Yellow Fever Situation in the Americas." All who are interested are invited.

The Eastern Sociological Society will hold its annual meeting at the Hotel Commodore, New York City, April 23–24.

Linus Pauling, president of the American Chemical Society and director of the Department of Chemistry, California Institute of Technology, will deliver the second lecture of the City

College Chemistry Alumni Association's bicentennial lecture series, April 29, at 8:00 p.m. in the Great Hall, City College of New York, Convent Avenue and 139th Street, New York City. Dr. Pauling will talk on "Structural Chemistry in Relation to Biology and Medicine." The public is invited.

The American Society of Medical Technologists will hold its annual convention June 20–23 at Hotel Roanoke, Roanoke, Virginia. Further information may be obtained from Ida L. Reilly, Roanoke Hospital Association, Roanoke, Virginia.

The American Physical Society, at its recent annual meeting, elected as president Francis W. Loomis, head of the physics department, University of Illinois. I. I. Rabi of Columbia University will serve as vice president for one year and will succeed Dr. Loomis as president of the Society in 1950.

The Oregon Academy of Science has elected the following officers for 1949: W. E. Milne, Oregon State College, president; F. L. Griffin, Reed College, vice president; F. A. Gilfillan, Oregon State College, secretary; and Lloyd Staples, University of Oregon, treasurer.

Dwight Willard Taylor, 17 years old, of the Webb School in Claremont, California, was named the **Westinghouse Grant Science Scholarship winner** at the banquet culminating the Eighth Annual Science Talent Search in Washington, D. C., on March 7. Taylor, who will use the $2,800 award to attend the University of Michigan, made a survey of mollusks on Nantucket Island and reported 76 species previously unknown there.

Caroline Stuart Littlejohn, 16 years old, of Classen Senior High School, Oklahoma City, Oklahoma, received the second place $2,000 Westinghouse Science Scholarship for her general science record and her essay on the mathematical theory of relativity.

Of the 40 high school students selected from 16,218 entrants to come to Washington for the Eighth Annual Science Talent Institute held March 3–7, eight were awarded $400 science scholarships: Thomas Calhoun Barr, 17, Hillsboro High School, Nashville, Tennessee; Pierre Euclide Conner, Jr., 16, Cathedral High School, Lafayette, Louisiana; John Ward Kimball, 18, Phillips Academy, Andover, Massachusetts; Henry Jacob Landau, 18, Bronx High School of Science, New York City; Thomas Francis Martin, 17, Cathedral Latin School, Cleveland, Ohio; Nicholas Reinhardt, 17, Terrace Park High School, Terrace Park, Ohio; Howard Alan Shugart, 17, Herbert Hoover High School, Glendale, California; and Ursula Vivian Victor, 16, Forest Hills High School, New York. The 30 other participants in the Washington Institute received $100 science scholarships.

The annual Westinghouse Science Talent Search is conducted by the Science Clubs of America with funds provided by the Westinghouse Educational Foundation and is administered by Science Service. The $11,000 in science scholarships may be used at any college, university or technical school of the winners' choice to continue training in science and engineering. In addition to the 40 national winners, a list of 260 students awarded honorable mention was announced on February 10 and recommended to college and university registrars who are recruiting students talented in science. Eighteen states conduct Science Talent Searches concurrent with the national competition to determine state scholarship awards.

The panel of judges—Harlow Shapley, Director of the Harvard College Observatory, Steuart Henderson Britt and Harold A. Edgerton, psychologists of New York City, and Rex E. Buxton, psychiatrist of Washington, D. C.—made the science scholarship awards on the basis of a science aptitude test completed by 2,482 of the entrants, recommendations and scholarship records submitted by the students' high schools, and original 1,000-word essays entitled "My Scientific Project."

The 31 boys and nine girls selected for the Science Talent Institute in Washington came from 32 localities in 17 states and the District of Columbia. Three states, Louisiana, Texas, and Utah, have winners this year for the first time.

Of the 320 winners named in the first eight Science Talent Search, twelve have come from the Bronx High School of Science and eight from Stuyvesant High School in New York City; seven from the Forest Hills (New York) High School; and 5 from the Herbert Hoover High School in Glendale, California.

Albert Einstein celebrates his 70th birthday on March 14 and to mark this occasion *Unesco World Review* is issuing a special supplement which will be entitled "Tribute to Albert Einstein." A 30-minute program, written by Niels Bohr, Danish physicist, Jacques Hadamard, French mathematician, and Arthur H. Compton, U. S. physicist, will be released to all radio stations receiving the *World Review*, for broadcast Sunday, March 13.

The Army Medical Department announces the development of a new drug, **"Dramamine,"** that acts as both a cure and preventive of seasickness or motion sickness. The original research was done by Leslie N. Gay, of the Protein Clinic of Johns Hopkins University Hospital, Baltimore, and Paul Carliner, also of Johns Hopkins. Recent experiments showed almost total cure or prevention of seasickness among more than 400 passengers aboard an Army transport in heavy seas.

The Smithsonian Institution has been presented with a collection of burrowing snakes of the Southwest—more than 2,000 specimens of the obscure, insect-eating *Sonora* and *Tantilla*, collected by Edith R. Force, of Tulsa, Oklahoma.

A Special Notice to Any Prospective Exhibitor in the Annual Science Exposition of the 116th Meeting of the AAAS New York City, December 26–31, 1949

If you did not receive a letter inviting your participation in this year's annual Exposition, and if you would like to receive the Official Floor Plan and Booth Rental Information on the release date this month, please write at once to: R. L. Taylor, Assistant Administrative Secretary, AAAS, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.